

THE  
**PRINCIPLES**  
OF  
Natural Philosophy,

In which is shewn the Insufficiency of the  
**PRESENT SYSTEMS,**  
To give us any Just ACCOUNT of that  
**SCIENCE:**

And the Necessity there is of some  
**NEW PRINCIPLES,**  
In order to furnish us with a True and Real  
**Knowledge of NATURE.**

By **ROBERT GREEN, M. A.**  
*and Fellow of CLARE HALL.*

**C A M B R I D G E:**

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*C. H. d.*

To the  
RIGHT HONOURABLE  
**ROBERT,**  
EARL of OXFORD,  
and MORTIMER,  
BARON of WIGMORE,  
LORD HIGH TREASURER  
OF GREAT BRITAIN,

AND  
One of Her MAJESTY's Most  
Honourable PRIVY COUNCIL.

MY LORD,

**H**AVING already publish'd a  
*Demonstration of the Truth and  
Divinity of the Christian Religion*, of  
which Your Lordship has been former-  
ly, as well as in the High Station You

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possess, so Eminent a Patron, by Your Encouragement of the Preachers and Dispensers of it to others, both in their Synods, and in their Private and Particular Functions, the Last, by being the Chief Promoter and Adviser of an Act, from the Legislature, to Confirm Her MAJESTY'S Royal and Unparallel'd Bounty to the more Indigent part of Her Clergy, and the First by Contributing Your Endeavours towards the Regular and Just Meeting of Convocations, You will permit me to think I could not inscribe these *Principles of Natural Philosophy*, to a Greater and more Worthy Name, than Your Lordship's; since, as the Demonstration of the Christian Religion is intended to Explain the Full and Entire Evidences we have for the Truth of it, so the Principles of Philosophy will Evince, what Little Satisfaction we are to Expect from Reason, and even from those, who have enter'd into the Depths of it with the utmost Genius and Penetration.

The Asserting therefore Religion, and shewing the Defects and Infirmities of  
what



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what is at present call'd Human Reason, in those Sciences, which have always laid the strictest Claims to it, and which, if any others, are capable of coming under a True Conviction, being my principal Aim and Design, I hope, and cannot but think, that the Piety of such an Intention will Excuse the Presumption of this Application to Your Lordship.

*My Lord*, as I have Originally Entertain'd this Opinion of You, that Your Purpose and Ambition in the Great Place You fill, and to which ALMIGHTY GOD has, in a Manner, Miraculously Advanc'd You, was to do Good, and to promote an Orthodox Faith and Religion amongst Christians, and which Opinion is one Reason of my Desire of prefixing Your Lordship's Name, more especially, to these Papers, so Your Lordship will allow me to profess another Inducement I had to it, which is, that Intimate Respect, and that Inexpressible Value, which I must here publicly own, as it is particularly known in this place, I have for Your Lordship's Character and Worth, in the incessant

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fant Sollicitude and Concern you Employ for the Service of the *British* State.

For albeit Your Lordship has done all that lyes in your Power for the Advancement of Religion, and the Fault will be in us, if we do not improve those Opportunities, which are given us, and altho' the Happiness of a Nation does depend, in a great Measure, upon the Religion and Goodness of it, yet Your Lordship has not stopt here, but Extended Your Care and Regard, under the Auspicious Influences of Her Sacred MAJESTY, to every other Branch of this Nation's Interest, both in the Encouraging of Trade, by the Prospect of a Lasting and Honourable Peace, and by opening a New Commerce to our Fleets, and in Securing and Vindicating the Liberty and Property of the Subject, by Ascertaining the Just Prerogative of the Prince.

When I reflect upon this, and the whole Conduct of Your Lordship's Ministry, together with that Countenance and Favour, which you shew to all Kinds of Learning, and, in a more particular  
Manner

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Manner, to the Universities, the Great Nurseries and Fountains of it, one of which Your Lordship has adopted into your own Titles, I am forcibly carry'd into an Admiration of those Immense Abilities, and that Universal and Comprehensive Genius of Your Lordship, which seems to be the Chief Human Security, next to that of Her Majesty's Life, of the *British* Church and Nation, and when I farther consider the Surprising Revolution made in this Kingdom, in Favour of Your Lordship, and the Imminent Hazards to which Your Life has been more than once Expos'd, in the Defence of Your Religion and Your Country, from which You have been as Wonderfully Deliver'd, as I cannot but Believe You to be Rais'd by the Providence of ALMIGHTY GOD for the Support and Patronage of our most Holy Faith, against the Insults of the several *Atheists, Deists, Socinians*, and, I may now say, *Arrians*, of our Age, as well as for the Safeguard and Protection of our Civil Rights and Immunities, in Opposition to those, who  
would

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would Sacrifice both to their own Sinister and Ambitious Designs, so Your Lordship will be assur'd, that under this Sense of Your High Worth and Merits, I do, with all Submission, beg the Favour and Honour, to Subscribe My Self with the utmost Deference, Veneration, and Esteem,

**YOUR LORDSHIP's**

*Most Obedient, and Most*

*Humble Servant,*

**ROBERT GREEN.**



# THE PREFACE.

§. 1. **I**T is not much to be wonder'd, tha' it is extremely to be lamented, that Atheism and Irreligion is so universally spread and diffus'd thro' all parts of a Nation, which has been hitherto on the contrary so remarkably famous for its primitive Zeal and Piety; since Philosophy, that great Instructor of our Reason, and the sole Foundation and Source of all our Natural Knowledge, has been of late too carelessly resign'd into the hands of those, who have apparently writ with a Prejudice to Religion, because there are some whose Venerable and Illustrious Profession it is to inculcate and teach it to the World.

§. 2. If therefore we endeavour to rescue this Noble and Divine Science out of the Guardianship and Patronage of such corrupt Invaders of its Innocence and Simplicity, who, instead of pursuing Truth without any byass, reason with Inveteracy and Design, we hope we shall perform an Office not unacceptable to Religion, whilst we at the same time evidence the Weakness and Absurdity of their Principles who oppose it.

§. 3. We would not, however, be here thought to charge all those with an Intention of Introducing a Licentiousness of  
Thought,

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*Thought, under the Modern Term of Free-thinking, whose Opinions in Philosophy we have not been able to assent to: Sir Isaac Newton, Mr. Halley, Mr. Raphson, and the other Excellent Writers of the Age, are Names too known and celebrated to ly under a Reproach, so affronting and derogatory to their Reason; these are not the Persons we mean, for whose Learning and Merits we must here profess the most entire Veneration, however, we have been oblig'd to depart from their Sentiments and Apprehensions of Nature, in obedience to a just, and, as we hope, an impartial Inquiry into it: The Gentlemen we design are of a much lower Class, Mr. Hobs Mr. Lock, and Spinoza, who, if the Philosophy we have taken upon us to confute, is false, will be found to have offer'd very little to the World that is true, and to have carry'd it with too great and assuming an Air, in the Confidence of Principles, which they did not understand.*

*S. 4. That these Men were fond, notwithstanding, of a Philosophy, the Reasonableness of whose Suppositions they could not make out, and only took for granted, we do not admire; since they, at least, saw the Consequences of them, namely, the Subversion and Ruine of Religion in general, and the establishing Deism, or worse, which they wanted, in Affront and Contradiction to it.*

*S. 5. They very well knew what Success Democritus and Epicurus had met with before*

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before them, in poisoning and corrupting the Principles and Morals of those two Flourishing States of Athens and Rome, from a like Imaginary Doctrine of Atoms, and their various actings, and interferences with each other; and tho' the Corpuscular Hypothesis was as unaccountable, and they could as little comprehend the Nature and Constitution of its Particles, as they could those of the Epicurean, they were yet certain, that both the one and the other, had the same tendency to Atheism, whose Cause they had espous'd, and consequently the best suited of any other Philosophy, to the Purposes they had in view of bringing a Contempt upon every thing that was Virtuous and Sacred.

§. 6. Nor was such a System, however absurd in its Contrivance, in an Age abandon'd to all the Enormities of a Profligate and Licentious Living, unlikely to meet with too general a Reception; for where Men have once made their Actions bad enough to need, they seldom want either Arguments or Inclinations to embrace an ill Philosophy: It is not therefore any ways surprizing, that the Corpuscular Account of Nature should be avow'd and contended for by such Patrons, who make their Enmity to Religion and Virtue, not their Affection to Truth, the Cause and Principle of their Researches.

§ 7. On the other hand, that Men of Sagacity and Learning, of the utmost Prohibity



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*and Goodness, and the greatest and most exalted Genius's of their Times, should fall in with the same Notions, can be no other ways explain'd, than from their being unwarily led into them, by the Authority and Impressions of those who writ before them, and not being at Leisure, from their abstruser Speculations, to examine into the more obvious Doctrines of Philosophy, tho' indeed the most necessary and fundamental to it.*

§. 8. *If therefore we have dissented from any of this Complexion, Men who are truly valuable, and deserve the Reputation and Applause they have acquir'd, we desire it may be our Apology with them, that we are sensibly affected, we cannot profess our selves of their Opinion, unless we are willing to renounce our Reason; that as they have calmly and impartially made use of those Faculties, with which God Almighty has endow'd them, in order to find out, as far as possible, the wonderful Effects of Nature, and the Causes of them, so we cannot but think, we are entitl'd to the same Liberty, whilst we employ it with no other Design; and that if we have been so happy as to put Philosophy upon its true Basis, we ought rather to expect the Thanks than be any ways apprehensive of the Resentments of those, whose Errors it shall be our Misfortune to meet in the pursuit of so just an End.*

§. 9. *We are yet afraid that those, whose particular Province it is to assert Religion,*

*and*



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and who have form'd their Arguments for it, and the Being and Attributes of Almighty God upon the Corpuscular System, should think we destroy Religion, when we cannot acquiesce in the Doctrine they propose. To these Persons therefore, who resolve their Divinity into their Reason, we are oblig'd to say, That we have as great and as true a Sense of Religion, as they can be suppos'd to profess, and if they are positive to receive or embrace no other Demonstrations of it, and of an All-wise and Super-intending Being, than what they Themselves have contriv'd upon Principles that are false, they will not take it amiss, if on the contrary we are certain, and determin'd to prove the same Important Points, upon Principles that are true.

§. 10. What we have therefore farther to add in this Preface, is, the Method which we intend in our present Philosophy, and the Reason of our communicating it to the World.

First, As to our Method, we shall first shew, the Unreasonableness and Absurdity of the greatest part of that Philosophy, which has been hitherto Receiv'd under the Name of The Corpuscular, which, as it mixes it self with all that has been yet extant in that Science, if it is not true, gives a like Impression of Error, and Falsity to the Whole.

Second, We shall from thence proceed to examine into the present Opticks, and Diop-

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tricks, and particularly Mr. Molineux's, as also into the Forces alledg'd in Mechanicks to explain Nature, and consider how far, and in what Sense they are serviceable to that End, under which Head we shall comprehend the Laws of Motion, Gravitation, and Attraction, of Elasticity, of Reflection and Refraction, of Hydrostaticks, the Affections of the Barometer, the Loadstone, the Flux and Reflux of the Sea, and the Revolutions of the Heavenly Bodies.

Third, After a particular Examination into each of these, we shall lay down those Principles, upon which alone we think it is possible for Nature to be explain'd; which we shall endeavour to do in that manner, that so Noble and Sublime a Science may no longer appear to be only a Handsome and Well-corriv'd Romance, as it has been till this time deservedly thought by the Wisest and most judicious Men, but a Study suitable to, and highly becoming a Rational Being, not a Sport of Gayety and Wit, but an Entertainment adapted to the most Solemn and Serious Exercises of our Minds.

Fourth, In order to this, we shall first demonstrate what real Solidity, Extension, and the several other Primary Affections of Matter are, and from what Principles they are deriv'd, how they are joyn'd and connected together, by an indissoluble Dependence upon each other in one Substance, that is, what the Substratum or Original Essence of Matter is, and from which those  
Pro-

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Properties do necessarily result, which are said to be in a peculiar manner essential to it; and in treating of these, we shall evince the incompetency of the present Mathematicks to furnish us with any just or adequate Reasonings upon Nature, and the Necessity there is of some new Principles in that Science, which we have in some part explain'd in the Geometry of Solids annex'd to this Philosophy, and from which we have been long since assur'd, that the Square of the Circle is not impossible.

Fifth, We shall afterwards demonstrate, from the same Essence of Matter, how all the other Properties of it, which are nam'd accidental are deduc'd from it, as Hardness, Fluidity, and Softness, Heat and Cold, Taste, Smell, Sound, Light, Colours, Motion, Attraction, Gravitation, Elasticity, Ebullition upon the Mixture of an Acid and Alkali, Chrystallization, Coagulation, and the other Operations and Effects in Chymistry, the Mechanical Powers, the true Laws of Opticks, and whatever else concerns the Active part in Philosophy, and under each Head endeavour to solve the Phenomenons which belong to it.

Sixth, From thence it will be necessary to proceed, and inquire into the Formation and Contextures of Bodies, the Causes of Vegetation, and the Constitution of Plants, how the Orbits of the Planets also are preserv'd, and what is the real Cause of their Revolution,

Seventh,



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Seventh, *We ought likewise, in a True Method of Philosophy, to inquire into the Nature and Temper of a Human Body, what Laws of Motion are observ'd in it, how its Oeconomy is preserv'd, and by what Means it is disturb'd, and disorder'd, and the Ways and Methods to be us'd to restore it; and since this cannot be known without considering the Nature of the Mind, and more especially, since Religion and Morality are in a particular manner concern'd in so abstruse a Science,*

*Eighth, We are to shew the first Principle of the Mind, and from thence, as before in Bodies, deduce its essential Properties and Affections, as Perception, Remembring, Judging, Willing, &c. how they depend upon each other, and are naturally deriv'd from the Original Essence to which they belong.*

*Ninth, The next Inquiry will Naturally be, how all the Accidental Qualities of the Mind may arise from such an Explanation, as the several Passions of Courage, or Fear, of Love, or Hatred, of Despondency, and Dejection of Spirit, or Haughtiness, and Insolence, of Anger, Revenge, and Ill-nature, or Mildness, Clemency and Compassion; all these in a true Philosophy, are to be accounted for, and which is the greatest Problem of all, how these Properties and Affections of the Mind, and the Mind it self, are compatible with, or can be united to Matter. We are also, in a true Philosophy, to explain what the Difference is be-*  
twixt

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twixt that Faculty of Thinking, which is evident in Brutes, in an inferior sense, and that which we experience in our own Minds.

Tenth, Having consider'd the Nature of the Mind, and from what Principle it owes its Being, as well as that of Body before, we are then to examine from a Contemplation of all Nature, what the Properties of a Superiour and Creating Existence are, from whom this Exquisite Order of Things is deriv'd, and from a Comparison of the whole to state and compute our true Notions and Apprehensions of a Natural Morality and Religion, the Duty we owe to the Sovereign LORD of this Great Universe, and the Obligations which ly upon us in relation to each other, which is the sum of Religion, and which, as by those General Reflections we have made upon the several Heads of Philosophy we have nam'd, we cannot conclude to be any other, in some measure and degree, than that Excellent Christianity we profess and own; Nature being one Revelation to us of the Almighty Justice and Goodness, and our Redemption a second, which gives us the same Impressions of the DEITY, which Nature do's, namely, that He is Beneficent and Just; but then this Notion of Him is rais'd and exalted to that Excellence and Perfection, by the Christian Religion, to which the best Philosophy could never arrive.

We dare not promise our selves that Extent of a short and transient a Life, as to be  
able

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able to go thro' this whole System, it will require more perhaps than several Lives to perform it; we shall yet proceed in it as far as our own infirm Constitution, and our other necessary Avocations will allow us to do, and endeavour to lay down such Principles, which may be easily carry'd thro' all the Parts of Philosophy we have nam'd, and leave the rest to the Divine Providence and Appointment.

§. 11. We must here take Notice, that in this Method of Philosophy, which we have propos'd, we mention'd the possibility of the Circle's Square, of which, as we have long ago been convinc'd, and have subjoyn'd some of our Reasons for it in our Geometry of Solids or of Matter, we shall at present ask, Whether the Parabola is not squar'd, and yet, Whether the Proportion is known betwixt its Curve and the Diameter of it? if not, as all the Mathematicks we have seen do acknowledge; if the Proportion is not asserted betwixt the Parabolick Curve and its Diameter, and notwithstanding this, it is confess'd, that the Square of the Parabola has been long since discover'd, let any one assign a Reason why, because the Proportion betwixt the Diameter and its Circle is not found, or cannot be, therefore the Circle is impossible to be squar'd; since the Chief Methods, which have been hitherto enter'd into to accomplish it, have been in the last result agreeable to that which Archimedes first propos'd of finding the Ra-



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Ratio betwixt the Diameter and the Circumference, whereas the Excellent Mr. Raphson has prov'd such an Investigation to be impossible, by the Surd Roots, which continually increase, and grow more perplex'd the nearer the Chord approaches to the Arch, to which it is drawn; thus if  $r$  is suppos'd to be the Radius, the side of a Square inscrib'd in a Circle, will be equal to  $\sqrt{2rr}$ , of an Octagone, to  $\sqrt{2rr} - \sqrt{2rrrr}$ , of a 16 lin'd Figure, to  $\sqrt{2rr} - \sqrt{2rrrr} + rr\sqrt{2rrrr}$ , &c. from whence he concludes, that the Circumference of the Circle is, perhaps, infinitely incommensurable with the Radius of it; and indeed it seems to be as evident, that we can never come to the Proportion betwixt the Diameter and the Circle this way, as it is, by Prop. 2<sup>d</sup>. Elem. 3<sup>d</sup>. of Euclid, that the Subtense, let it be as small as it will, can never be commensurate to its Arch; that is, there is no part of any Right Line which can ever measure a Curve; which is manifest from the Nature of a Curve, and a Streight Line drawn betwixt the same points, since they will always be distinct from each other, so long as they preserve the properties, under which they are suppos'd to be examin'd; if the Subtense is diminish'd, till it becomes no longer so, but falls in with the Curve it self, and is a point of it, we are left as much in the Dark, as to the Nature of the Curve, as if we had never made the Comparison betwixt its Archs and its Subtenses.

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ses, and had only consider'd the Curve it self, without any such streight Lines inscrib'd in it; besides it is very well known, that from Prop. 13. Elem. 6. of Euclid,  $db$  is a middle proportional betwixt  $ab$  and  $bc$ , and consequently if  $b$  approaches infinitely near towards  $a$ ,  $ab$ , or, which is the same,  $a$ , will be an infinitely small part of the Diameter  $ac$ , and multiply'd into it will be equal to  $ad^2$ ; on the other hand, according to the Doctrine of Subtenses, let the Diameter  $gf$  be mov'd parallel to it self, so as at length to subtend, by an infinitely small portion of it, an infinitely small Arch in  $de$ , or  $a$ , in this Case, either the Subtense in  $a$  is equal to the Arch in  $a$ , or not; if it is not, an infinitely small Subtense is not the same, as an infinitely small Arch, and therefore the one cannot be express'd by the other, nor the Circumference, by a Polygone of an infinite number of sides; if it is, since  $ad^2$  in such a Circumstance will be equal to  $\frac{1}{4} a^2$ ,  $a \times ac$  will be equal to  $\frac{1}{4} a^2$ , or  $\frac{1}{4} a$  equal to  $ac$ , that is,  $\frac{1}{4}^{th}$  of an infinitely small part of the Circumference will be equal to the whole Diameter, or one point in it equal to 4 Diameters of the Circle: Lastly, in the confess'd Generation of a Circle, it is in every point compounded of a Tangent and a Centripetal Direction, and therefore any point of it can be as little represented by a strait Line, as a compound Direction can be express'd



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press'd by a simple; from whence, and from other Reasons, which will be too tedious here to enumerate, it seems to be evident, that a curve Line is as incapable of being compar'd with a strait, as a Point with a Line, or a Line with a Superficies, or that with a Solid, and consequently, that all the Polygons inscrib'd, and circumscrib'd to a Circle, can have no manner of relation to it, so as to confine the Dimensions of it within the Limits they shall prescribe; and for the same Reason, as the Square of the Circle seems to be impossible in such a way of proceeding, so if it is found upon other Principles, it is manifest it cannot be examin'd by these, and on the contrary, that the Proportion betwixt the Diameter and Circumference will not result from ascertaining the Ratio betwixt the Circle and the Square, since the contents of the Circle, divided by the 4<sup>th</sup> part of the Diameter, is not equal to the Circumference, unless upon the supposition of its being compos'd of an infinite number of the sides of a Polygone, whereas we cannot acquiesce in any Demonstrations, which affirm the Circumference expressible by strait Lines, be their portions as small, and their number as great, as it is possible for us to imagine them: Moreover, it seems to be manifest, that there is no connexion betwixt the squaring of any Figure, and the finding the Ratio of its Lines, which determine it; thus tho' the Triangle is half of the Square which it divides, yet the



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*the Diagonal of the Square is incommensurable with the side of it; and in general, the Comparison of Surfaces must proceed upon a different Reasoning from that of Lines; because where two Surfaces are consider'd, the same number of points is suppos'd in Lines, which in their relation to each other, are imagin'd to have no common measure, as in the Instance before alledg'd, of the Diagonal and side of a Square.*

*We shall not, however, enter into these Points now, since we intend to reserve them for our Discourse upon real Extension, and the Geometry of Solids or of Matter, affix'd to the present Philosophy. This Problem, yet brings to my Thoughts that other Famous one amongst the Grammarians, in Virgil's 3<sup>d</sup> Eclogue, for a Solution of which some have gone as far as Ægypt and Æthiopia, and think that the Tres Ulnas respect a Well in Syene, others to Sicily, and interpret it of the Cave there, from whence Proserpina was ravish'd by Pluto; a third sort will have it refer to Ajax's Shield, which was of those Dimensions, and had the Portraiture of the Heavens describ'd upon it, &c. On the other hand, the Flores Inscripti, are said to be the Hyacinth, into which the Boy of that Name, and Ajax afterwards was transform'd; or else, a certain piece of Money, which had the Effigies of Augustus on one side, and a Flower on the reverse; whereas both by the Nature and Design of that Eclogue, and the Con-*  
trovery

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troverſy maintain'd betwixt the two Shepherds, which was concerning Subjects which preſented themſelves immediately to their ſight, and by the Reply, which was always adapted to what went before, it ſeems plain, that the former was only a Lake of Water, which lay under the Shepherd's view when he propos'd this Problem, which the other ſhews he underſtood, by pointing him to a Lawrel and its Leaves or Flowers, that grew by it, and which was writ or inſcrib'd upon their Coins, and with which the Names and Effigies of their Great Men were adorn'd; we only mention this, at leaſt, as a more probable Account, than what has been hitherto given of that paſſage, and at the ſame time to ſhew how apt we are to labour in difficulties, which we make more learned indeed by our Inquiries, and that is all; when if we attempted them in the ſimpleſt and moſt Natural way the whole perplexity would ſoon vaniſh; and this appears to be the Caſe of the preſent Problem amongſt Mathematicians, which is rather made more intricate and entangled, by the ſubtleties rais'd upon it of Infinite Approximations, than any ways clear'd or explain'd by them; and ſuch we take to be the Caſe of Mr. Halley's Quadrature in Mr. Sherwin's Mathematicks.

On the other hand, the Method we proceed in, in ſquaring the Circle, is no other than that which the Excellent and Incomparable Dr. Wallis has us'd in ſquaring the Parabola, that is, by conſidering the Areas  
b and

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and Superficies of each, without inquiring into the Nature of the Lines which terminate them; and according to this procedure, (which, whether Accurate and Just, we shall, at the end of this Philosophy, submit to the Sense and Judgment of the Learned World;) we are at present as fully convinc'd from the way of Reasoning made use of in the Arithmetick of Infinites, that the Circle is to the Square circumscrib'd as 4 to 5, as that the Parabola is to its Square, as 2 to 3.

§. 12. We have therefore little more to offer in this Preface, unless to let the World know the Reason of our appearing in it against the present Philosophy, which is only this, That we find too many of those, who make any pretences to the Study of Nature, ready, or, at least, in some degree, prepar'd to revolt from their most Holy and most Divine Religion, upon those Principles, which are the most Absurd and Irrational that can possibly be conceiv'd, as those of the Corpuscular System, I hope we have prov'd and demonstrated to be.

§. 13. If yet we have not done that, we are very well satisfy'd, that there can be no true Arguing upon Nature, excepting in the Method we have lay'd down, that is, by considering it in the several Parts and Distinctions of it, which we have mention'd, and making one consistent System of the Whole; for it is not sufficient to give a Solution of this or the other Phenomenon (as the Rain-  
bow



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how or the Magnet, or the Refractions of Light thro' different Mediums) independent of all others, these are only Pretty Exercises of Wit and Fancy; whereas a true Account of Nature, ought to be agreeable in every part to that Universal BEING, which is endeavour'd to be explain'd by it.

§. 14. And yet if we observe the way of Reasoning in use amongst the present Philosophers, we shall find some of 'em taking one part of Nature, and others a different, and if upon their particular Suppositions and Hypotheses, they can solve those Phænomenons they chuse to contemplate, it is thought, without having a respect to any thing else, that their Solutions are true, tho' the same Suppositions are not, perhaps, capable of accounting for any other Appearances we can Name.

§. 15. A True and Impartial Consideration of this, obliges me to reflect with a just Indignation, and Contempt on the Presumption of those Men, who before they have gone one step in this Method, which we ought to use in a real Philosophy, and without which it will be impossible to discourse rationally, and with consistency upon Nature, do yet set up for Adepti in that Science, upon the false and lazy Reputation of being, as they call themselves, Lovers of Truth, which is only another Name for their Insolence to Religion, and their bold Affronts of every thing that is virtuous and good.

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good. These have not Application nor Sagacity enough to go through the several Mazes and Labyrinths of Nature, and explicate the Difficulties they shall meet with in a laborious Search, which should be previous to their Inquiries into the more complex Rules of Morality, and yet for all this, they think themselves without any true Knowledge in Natural Philosophy, capable of discoursing very solidly and substantially upon Natural Religion; tho' the last, according to the Method we have recounted, is nor can be, no other than the result and consequence of the former.

§. 16. We cannot likewise but, in some measure, blame those Divines in our present Age, who are too fond of what they call Rational, who put too great a stress upon their Reasonings from Nature, when so little of it is understood by us; for we dare be bold to say, that those Arguments, which Christianity furnishes us with, for the Truth of Religion, and which we have explain'd in our Demonstration of the Divinity of it, are more certain and conclusive, than any that are supply'd to us from the present Philosophy, tho' they have the Name likewise of Demonstrations affixt to them; or rather we may affirm, there is no Comparison betwixt them; we shall only farther wish that what we either now publish, or afterwards shall, may be to the service of Religion, and the unprejudic'd Reason of Mankind, either of which good ends, if we shall

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shall be capable of attaining in any degree, we shall think our pains abundantly compensated with the pleasure and satisfaction we shall receive from it.

§. 17. Since the writing of what foregoes, I must add my grateful Acknowledgments to the Reverend and Worthy the Master of this College, and to those several Members of it, by whose Kindness and Good-will to me, I have had the Happiness to be plac'd in so Learned a Society, whose Extraordinary Favours to me, by which I have been encourag'd in the pursuit of my Philosophick Studies, require this publick Testimony of my most sincere and thankful Resentments of them.

Nor can I omit to profess that intimate sense which I have of the Obligations laid upon me by this whole University, who by their Subscriptions to the present Philosophy, have shewn they are not to be guided by the Authority of Names, but are willing to embrace Reason, from what Hand soever it comes.

'Tis also with the utmost pleasure and satisfaction, with which I recollect the kind and ready Assistance afforded me, in the Transcribing of these Papers, from my Dearest and most Excellent Pupils Henry Palmer, and George Newsome, Batchelors of Art, both lately elected unanimously into this Society, in reward of their uncommon Merits, Piety and Learning, and whose good Offices to me in the



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*particular above-mention'd, I desire it may be allow'd me, to take this Opportunity of professing to the World.*

§. 18 I must lastly advertise my Reader, that after I had printed off the most of this Philosophy, namely, the First part of it, and Two or Three Chapters of the Second, which concern Light and Colours, I was inform'd there was a Book publish'd in Holland, which seem'd to assert the same Principles; but any one who compares both, tho' we agree in a Plenum, according to Chap. 4, 5, 6. Part 1. and that Body or Matter cannot be confin'd to a Trine, or a Triple Dimension, according to §. 1. Chap. 4. Part 1. and the Geometry of Solids or of Matter, subjoyn'd to this Philosophy, will easily perceive, that these Principles are different from those above-nam'd, and that there is no Analogy betwixt them; for as the present Philosophy is levell'd against the Corpuscular in general, so as that Author spends a great deal of pains in explaining the Figures, Scituation and Order of the parts of Natural Bodies, it is evident we entirely dissent from him, whilst we affirm, that the Divisibility, Parts, or Contextures of Bodies, are of no Importance to the Solutions of any Phænomenons in Nature.

To conclude, if any thing, in this Philosophy, shall be found in the least to interfere with our most Holy and Christian Religion, I shall be the first Person ready to blot it out, and erase it from the present System,

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*System, there being no Rational Science, nor any Natural Religion which has the like Evidences, which Revelation has, and nothing in the whole World, which could so effectually contribute to the real Happiness and Advantage of Mankind, both in this Life and a better, as that Divine Institution and Oeconomy, which is deriv'd from it. And as to any Errors or Mistakes, in respect of Reason, it cannot be expected we should be entirely free from them, who are oblig'd to proceed in a different Method from that which any Philosophers have done, and therefore are depriv'd of those Assurances from others, which might be some kind of Direction to us in our Inquiries: We yet persuade our selves, our Failures, in this point, are not so gross and numerous, as those which are every where obvious in the present Hypotheses of Nature; and if we have been incautiously carry'd into any undue Conclusions, we hope they will be excus'd to that sincere Affection for Truth, both in Philosophy and Religion, which has principally Animated us in this whole Undertaking, which has the absolute possession of our Thoughts and Aims, and which we shall cherish and pursue to the Last Breath of our Life.*

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of

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61. *The Reason of our Dissenting from the present Philosophers.*

ERRATA.

# ERRATA.

**P**Age 2 Line 27, for *our*, Read *their*. l. 30, for *that*, r. *there*.  
P. 15 l. 13, r. *because*. P. 17 l. 13, r. *into* for *unto*. P. 30  
l. 35, r. *Colour* for *Colours*. P. 47 l. 37, r. *Ingenuoufness*. P. 99  
l. 20, for *Indefinite*, r. *Infinite*. P. 109 l. 2, r. *Figure the first*. P. 110  
l. 17, r. *Independent*. P. 112 l. 22, for  $1000$ , r.  $2000$ . P. 120  
l. 31, for *Besides that, it is*, r. *Besides, that it is*. P. 149 l. the last  
for *their*, r. *the*. P. 203 l. 11, dele *on the other hand*. P. 212 l.  
37, r. *Circular*. P. 230 l. 35, r. *Mr*. P. 290 l. 9, r. *as reasonably*  
P. 310 l. 33, r. *Principles*. P. 316 l. 12, for *refracted*, r. *reflected*.  
P. 324 l. 14, r. *Prop. 1*. P. 334 l. 10, for *Appearance*, r. *Appear-*  
*ance*. P. 360 l. 2, for *only not*, r. *not only*. P. 390 l. 25, r. *Mr*.

THE

# THE PRINCIPLES OF Natural Philosophy.

## CHAP. I.

*Concerning the Existence and Truth of our  
Faculties, and our Reasonings from them.*

§. 1. **I**F any one desires to search into the hidden Causes of things, and is willing to take the pains of inquiring by what secret and unknown Springs all Nature is acted, what Laws she obeys, and into what kind of Principles she is ultimately resolv'd, it seems necessary for him in the first place to consider, Whether there is any such Being in reality which we call *Nature*, or whether it is not a manifest De- lusion and Imposition upon our Senses, or some way or other produc'd by the force of our own Imagi- nations; if so, it is in vain to tire our selves with te- dious pursuits after a Knowledge which is never like- ly to be obtain'd, and it will be the same with the *Philosopher's*, as the *Poet's* Dream, and the Image it presented, namely to vanish out of our embraces when we think we have the fastest and surest hold of it.

§. 2. In order therefore to determine so material a Question, it will become us to examine how far and in what sense we ought to doubt of every thing. If by that is meant that we should not believe our own Faculties till they are evidenc'd to be true, it is no more than to say we should not believe them at all;

A

since

*The first thing  
to be consider'd  
in Philosophy, is  
whether there  
is any real Ex-  
istence in the  
World or not.*

*What sort of  
Doubting Scep-  
tical and Un-  
reasonable*

since they cannot admit of an Evidence superior to their own, not from the Veracity of Almighty God, the Proof of whose very existence depends upon the truth of our Perceptions, nor yet from our Reasonings upon our Perceptions themselves, which are only the result of a due arrangement and disposition of them.

*How far we  
may doubt of  
every thing.*

§. 3. This indeed we may do, we may suppose that hitherto we have taken things upon credit, that we have given our assent to several Propositions without due information, and therefore being resolv'd to begin all our Knowledge anew, and to settle it upon sure and firm foundations, we doubt, that is, we suspend our Judgments concerning those matters, which we have till this time receiv'd and embrac'd, without the least pause or hesitation. And consequently we may likewise thus far doubt of our Faculties, but no farther than to give ourselves time to reflect upon and consider them, and impartially examine whether any real Objections can be made against them; such a Doubting as this is not only just but commendable, and no rational Inquirer into Nature can satisfy himself without it, because it is no more than suspending our assent till we meet with a full and manifest conviction. This is not, however, to deny or doubt of the truth of our Faculties, notwithstanding our Evidence, but to weigh matters, and try whether there can be a greater and more forcible produc'd in opposition to it, and till that we will not pronounce whether we may entirely acquiesce in them.

The difference of this Opinion from that which Scepticks maintain, who pretend they are sure of nothing, is that they doubt of the real truth of our Faculties, because not yet prov'd (and which it is impossible they ever should be, if once doubted of) whereas we doubt of them, or rather suspend our assent concerning them, because the merits of the cause have not been yet examin'd; that is, they doubt



till they can find a Demonstration of them; we only till we have consider'd what is objected against them, and the force of the Arguments which are produc'd for them; or which is the same, we do not pronounce any thing concerning the Certainty of our Faculties existing, which is what we intend by Doubting, the Mind is put in a state of perfect Suspence, and do's not propend or incline to one hand or another; whereas what is properly meant by Doubting, is, when we acknowledge it uncertain, whether our Faculties do exist or not, upon some appearances or other of Reason; so that the Mind in such a case is no longer indifferent, but has actually assented to this Proposition, *viz.* That it is uncertain whether our Faculties exist, which is different from what we assert.

§. 4. In this sense then let us suppose Nature to be *In which Sense*  
 one universal Blank, all our former Perceptions as well *of Doubting, as*  
 as Knowledge to be lost and eraz'd from our Minds, *before expres-*  
 and that we were perfectly clear of all the Prejudi- *sed, we suppose*  
 ces and Impressions we had receiv'd from Custom *that nothing*  
 or Education; that is, let us now imagine that we *is absolutely*  
 began to think and exist, and let us prepare and *known to us.*  
 fortify our selves with this Resolution, that we will  
 admit of nothing for truth till we have first fully  
 examin'd all the Circumstances and Relations under  
 which it lies to us.

§. 5. When we say that all things should be con- *Whether all the*  
 sider'd, as if we began this moment to think and exist, *see is not mere*  
 we mean only in respect of our Knowledge, since we *Imagination.*  
 resume all our Faculties in full force and vi-  
 gour, and perfectly exercis'd to discern and distin-  
 guish our Perceptions, and to reason exactly upon  
 them; which possibly would not be allow'd, if we  
 were but just come to the use of them: Let our  
 senses now be set open and made free to receive  
 their proper Informations from things without us,  
 we immediately find our selves surrounded with a  
 world of Beings, but all the Question is, Whether  
 this

this is not a pleasing Dream, and the whole do's not rest in the Imagination only.

*The way to  
prove External  
Beings not to  
be the Crea-  
tures of our  
Imagination.*

§.6. As therefore Mathematicians begin their Demonstrations from those Steps which were the last in the Process, by w<sup>ch</sup> they arriv'd at their Knowledge, so it will not be any ways preposterous to prove the certainty of Beings external to us, tho' possibly first known, from that of our own Reflections upon the Impressions they make, which are the last, that is, to trace the Effect back to the Cause which produc'd it, and from the Nature of our Perceptions evince the necessity of other Beings as well as our own.

*Our own Per-  
ceptions are first  
to be examin'd,  
which, till they  
are, we doubt  
of 'em.*

§.7. In pursuance of which, the first thing we perceive in our selves is, that we think, that we reason, and judge, and this is so evident and plain, that we see no cause to doubt of it; however we will so far doubt as to suspend our assent, till we know what it is that can possibly be alledg'd against our being perfectly assur'd of it, which is no more than to say, we are not so far prejudic'd on the side of Demonstration it self; that we will not give a fair and impartial hearing to any Arguments which shall be brought to oppose it; that is, what we mean and intend by such a Doubting is only that we are not prepossess'd, and that we wave determining upon the strongest Evidence, whilst there is the least pretended to ly against it.

*The Reason  
why we may  
be certain that  
we perceive and  
think.*

§.8. If it be therefore now inquir'd of us, how we know we perceive, or think, or judge, or remember, &c. which are only several ways or manners of Perception, we answer, because our Perceptions are themselves and nothing else, if they are differing from themselves, it is not impossible for a thing to be what it is, and not what it is, or which comes to the same, we may without any offence to truth, affirm two contrary Propositions; If our Perceptions are themselves then the Question is, Whether they are something or nothing, if they are nothing, there is no differ-

Chap.I. *and our Reasonings from them.*

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rence betwixt Perception and no Perception; that is, it is the same Perception when I see the Sun and when I do not see it, but if Perception is it self and nothing else, and at the same time is something, then Perception do's and must exist:

The next thing to be determin'd is, Whether *we* perceive; we say therefore, so far as we are intelligent Beings in that Sense of *we*, for we do not at present consider the Material or that Corporeal part which belongs to us, either our Perceptions are our own or they are not, if they are, then we perceive, that is, we exist intelligent Thinking, perceiving Beings, because it is already prov'd that our Perceptions exist: If our Perceptions are not our own or our selves, then Perception is not it self contrary to what has been before evinc'd; for if Perception is it self, then our Perception, which is the Perception we now consider, is our own and our selves;

Nor do's it matter here whether these Perceptions are produc'd from one Cause or another, whether by Almighty God immediately or from External and Corporeal Objects, or from the force of our own Faculties, or from a Dream or any other way; since the Effect, not the Cause, is at present inquir'd, and the Question is not by what means we perceive, but whether we really do perceive.

This is not however propos'd as a Demonstration different from that of our Intuitive Knowledge, being no other than that Intuitive Knowledge it self drawn out into the several Axioms of it, in order to shew the extreme absurdity of those who can doubt of the truth of their Faculties, since they must be oblig'd at the same time to deny Propositions as plain and manifest as that *two* is not *three*, or that *five* is equal to it self.

§. 9. From the foregoing Section it seems evident that we do perceive; but it may be said, *Obj. of our Perception being a Dream, answer'd.* may not all this be a Dream; there is nothing can be more absurd than such an Objection, if

it is made and design'd against our real and actual Perceptions, since it must be own'd that in Dreams we have as just and as true Perceptions as when we are the most awake, however they are delineated upon the Mind, and by what Methods, and from what Causes-soever we can imagine, which is not at present the Inquiry; all the difference we find in Dreams from being awake, is only this, that our Perceptions in them are not agreeable to the real Existence of things, that they are confus'd and incoherent in the one Case and not so much in the other, and that they change too quick for our notice, where we have not our Reason and Judgment to curb the impetuosity of those varying Images in the Mind, which succeed one another without order or distinction; so that many times when one representation has enter'd the Mind, as for instance, that of a Man, it shall immediately alter successively into very different ones, as a Wolf or a Monster, &c. whilst the Mind at the same time apprehends those several appearances to belong to one individual Person of which it was then Dreaming: This notwithstanding is no more an Argument against our really perceiving than the false Reasonings even of Men of Sense, or the unaccountable Whimfies of Men under a Distraction are, which our Dreams would be a lively picture and representation of, if we were to converse with others amidst the wild and extravagant Fancies we experience in them.

If we therefore affirm that it is not certain, we perceive, because we may only dream so, it is no other than to say we are not sure we perceive, because we possibly may not connect our Perceptions agreeably, or may mistake one Perception for another, both which Cases do imply and suppose Perception in the very Argument which is brought against it; but if there is any other Notion of dreaming besides what is drawn from Nature, and which we have explain'd, it is an imaginary one, that there

can



can be no Definition given of, unless that it is the *Dream* of a Dream, which when it shall be fully explain'd what it is, it will be time enough to shew, we have no reason from thence to distrust the truth of our Perceptions.

§.10. Besides what has been hitherto alledg'd, those who question the truth of our Perceptions, either do it upon some grounds, or upon none; if upon none, the Case is plain against them; if upon certain Reasons and Conclusions, it is to be ask'd, Whether they do not do it upon a Perception of those Reasons and Conclusions; for if they do not perceive those Conclusions, they do it upon no grounds at all, and consequently the Case, as before, is evident and palpable against them; if they do perceive their Conclusions, then that very Perception is a Confutation of their own Argument; *i. e.* it is impossible for those who doubt of our Perceptions, to bring any Reason why we should doubt of them, whose Evidence is greater than that we perceive, or rather whose Evidence do's not depend upon that of our Perceiving.

§.11. But notwithstanding this, I know it may be urg'd against us, that we are so often deceiv'd, that we cannot be certain of any thing, and particularly as to what concerns our Perceptions, it is very frequent for us to think we see a thing, when we really do not, therefore why may we not be deluded in thinking we perceive, when in truth there is no such Perception; To which the Reply is not difficult, because all the Exceptions which can possibly be made against our Certainty of any thing are chargeable, not upon our Perceptions, but upon our Judgments of, or our Reasonings about them; for there cannot be the least Instance given, where any one did not perceive what he did perceive, tho' he might be mistaken in the Judgment which he made of such a Perception, in attributing it to a wrong Cause, or affixing it to, and joyning it with something

*Those who argue against the truth of our Perceptions, suppose what they endeavour to confute.*

*Obj. from our being often deceiv'd in the plainest matters, answer'd.*

thing foreign to it, which did not enter into the Nature and Being of the Perception itself: This, however, is no Argument against the reality of our Perceptions, but against our being infallible in our Conclusions upon them, which no one ever yet defended.

*We do not make a judgment of our Perceptions in the true sense of that Word, or if we do, it is infallible.*

§. 12. It will be therefore farther inquir'd, Whether we do not make or form a Judgment upon our Perceptions, when we affirm that they exist, because we perceive them; this indeed seems to be the last Objection which can be made, and wants no other Solution than the saying, that we do not make a Judgment of our Perceptions in the present Case, since to make a Judgment of any thing, or to reason upon it, supposes, as in Sect. 11. (in which respect we are only deceiv'd) that we consider something that is foreign and extraneous to our Perceptions; whereas when we say our Perceptions exist because we perceive them, is no more than to affirm, according to Sect. 8, that our Perceptions exist, because they do exist, since it is there prov'd, that *Our Perceptions* is the same as to assert *we perceive*.

If Judging is taken in any other sense, than comparing different Perceptions together, and determining upon them; that is, if by judging is intended the taking only one individual Perception, and pronouncing that it is what it is, such a Judgment indeed we make of our Perceptions, but then it do's not fall under the number of those fallible ones, which should bring the reproach of uncertainty upon it, seeing it is a most indubitable Maxim, and was never found to impose upon or deceive us: And yet by this way of arguing, because we are not always sure that we joyn and connect different Perceptions together aright, we cannot be satisfy'd whether we may affirm any one Perception is no other than it self, or that it is impossible for the same thing to be and not to be: The whole Objection therefore comes to this only, that because there

are some Judgments we have made which have deceiv'd us, therefore we cannot, nor must not trust to those which never could nor did.

§. 13. That we perceive then is manifest; that we likewise reason and judge, that we remember, that we will, and that our Minds really operate as we think they do is as plain; since all these are only different Perceptions within us, and of which the Mind is perfectly conscious, but as before we did not inquire into the Causes of Perception, so now, neither do we into those of willing, or judging, or remembering; it is sufficient at present that they exist, which is very evident from the Existence of each Perception in us of those several Faculties and Operations; 'tis true it may be said, that our perceiving these Powers in the Mind is only a proof that we have a Perception of them, but not a real Demonstration that they exist there; but we are withal to consider, that the Operations of our Minds, which necessarily infer the Powers of those Operations, are our Perceptions themselves, which have been already evidenc'd to exist; When we reason, or judge, or will, or remember, and let us take any other Action of the Mind, it is still resolv'd into Perception; and if that Perception is truly existing, that Action must be so, and there is no manner of difference in the Nature and Essence of the Operations of the Mind, only in the Denomination which we give them; thus the Nature of Judging or Reasoning is only a Perception upon several preceding ones, that of Remembering is no more than a repeated Perception of the same thing, and perceiv'd to be so; that of willing a Perception of something which determines us; but by what we are determin'd, or how or which way we remember, or the Rise and Cause, or the true Methods of Reasoning and Judging do's not concern us; it is enough if the Operations of the Mind consist in Perception, and consequently

*All the Faculties of the Mind are equally certain with Perception, since the Faculties of the Mind are inferr'd from its actual Operations, and those Operations are our Perceptions themselves.*



quently if one as well as the other do's really exist.

*The considering  
the Faculties of  
the Mind as di-  
stinct Beings in  
it, an occasion  
of Error.*

§. 14. From what has been said, we have just reason to blame those who speak of the Powers and Faculties of the Mind, as distinct Beings from each other, whereas they are all one individual Being, and only receive different Appellations from our different way of considering the same real Perception: This however has been the occasion of the Objection we before mention'd, namely, that tho' we did perceive these Faculties of our Minds, yet it was not from thence necessary they should exist, whereas the Powers or Faculties of our Minds are concluded from the Operations or Actions we experience in them; and since they are no other than different manners or ways of Perception, all these Faculties which have been so essentially distinguish'd are no other in reality than the Perceptive, which has been fully prov'd to exist from the Existence of Perception, and by consequence, that all the Powers and Faculties of our Minds, and all that is deriv'd from them, do so too, *i. e.* that we exist Intelligent, Thinking, Reasoning, Willing Beings, with all the Properties and Affections which have been hitherto attributed, or apprehended to belong to us.

*As our Facul-  
ties exist, and  
are true in that  
respect, so are  
they likewise in-  
fallible and cer-  
tain in their  
Conclusions,  
where due care  
is us'd.*

§. 15. We have no reason then to doubt of the truth of our Faculties, any more than of our Perceptions, they are such as our Minds represent them to us; granting therefore our Faculties are true in respect of their existing, and their representing our Perceptions right, if after this it should be ask'd, Whether they are true in another Sense, that is in ever furnishing us with just and infallible Conclusions when we use them, with the greatest Caution and Circumspection; or which is all one, whether we can be assur'd of any thing in our Reasonings upon our Perceptions; it is certain we may; since this truth of our Faculties do's necessarily result from the other;



ther; for if our Perceptions are true, then there is an actual and real Distinction of them, or, which is the same, if every Perception is it self, and is therefore such as it appears to the Mind, the Mind must perceive the Agreement or Disagreement of them, upon the very account that it perceives them; and therefore we may infallibly affirm, that one Perception is not the same as another Perception, which is different from it, or that one Perception is the same with another to which it exactly corresponds; but the whole of our Reasoning consists in nothing else than comparing several Perceptions together, and distinguishing betwixt them where they differ, or making no Distinction betwixt them where they agree; on the other hand if we take one Perception for another, which is not answerable to it in all respects and relations, or make a difference betwixt them, where all things consider'd they are the same, it is then and then only that we are deceiv'd.

Thus if we affirm that *three* added to *three* is equal to *six*, it is upon the Perception of one Unit being equal to it self, and an equal Collection of them being so too, on the contrary, if we affirm that *three* is not equal to *four*, it is upon a Perception of their Disagreement with each other, from the Agreement of what is known to be the same; for *three* is not equal to *four*, because *Unity* is equal to it self, and *three Units* equal to *three Units*, and therefore not equal to *four*; and it is the same in the abstrusest Reasonings in the Mathematicks or Philosophy; as the Square of the Hypotenuse being equal to the Squares of the sides or any other Theorems in Geometry, which in the last Result, if true, are resolv'd into Identical Propositions, and the Relations which they bear to each other when distinctly compar'd.

Thus

This however only respects that kind of Reasoning, which concerns those Sciences, whose foundation is in the Mind, and are built upon the Perceptions observable in it, for there is a Reasoning and Certainty, which arises from other Principles, and where the Agreement or Disagreement of our Perceptions can have no place, as in Matters of Testimony; since if ten thousand Persons, of undoubted Integrity, should alledge they have seen such a place as *France* or *Italy*, we from thence know and are sure there are such Countries, tho' there is no deriving that Knowledge or Assurance from any Comparison of the Perceptions of our own Minds, and there is less danger of our being misled from an Information of that Nature than from the other; because the Mind when it lays down Principles of its own, and argues from them, admits of a chance of being doubly deceiv'd, both in its Principles which it contrives, and in its Arguments upon them, whereas in Matters of Testimony, the Fact is given and the Arguments upon it are only consider'd.

Lock's Notion  
of Certainty,  
partial and ab-  
surd, *Essay* Ch.  
2. B. 4. Ch. 4.  
B. 4. §. 18.

Having therefore endeavour'd to evidence the truth and certainty of our Perceptions and our Reasonings, and our Judgments upon them, where due Care and Attention is us'd, we seem now to have fix'd some sure Foundations, upon which our Knowledge may proceed with Security; our next Business is to prove, That Things without us exist, as well as the Powers and Faculties of our own Minds, which however it has been hitherto \* de- pair'd of, we shall endeavour to evince in the following Chapter.

\* Malbranche  
Eclaircisse-  
ment sur Ch.  
10 Recherche  
de la Verité. p.  
34 Dr. Clark's  
Annot. on Ro-  
bault, p. 10.

*A Demonstra-  
tion of an Al-  
mighty Being,  
ought to be con-  
cluded from a  
Contemplation  
of all Nature,*

§. 16. I know after a Conviction of our own Existence and the truth of our Faculties, we might now farther proceed to the Demonstration of an Almighty and Allwise Being; but since the *Apostle's* Argument is, that from the Visible things which are created, may be evidently collected his *Eternal Power*

Power and Godhead, we rather chuse to consider the Constitution of things in general, as well as that of our own Existence, before we enter upon so Divine an Argument; it being more agreeable to a Rational Philosophy to consider the Forces of Nature, abstracted from a Supreme and Superintending Influence, and to a Pious one to make the Demonstration of Religion, the End and Conclusion as well as Design of all our Speculations.

## C H A P. II.

*Concerning the Reality and Existence of External Nature.*

§. I. **T**HAT there are Beings exist without us, tho' it is probable, yet Philosophers have it seems accounted it impossible to be prov'd; But as it has been laid down for a Fundamental Maxim, not to determine upon any thing till we have duly weigh'd and consider'd every part of the Argument; so we are not to make the Opinions of others the Standard and Measure of Truth, nor is it reasonable for us to suffer either Prejudice or Authority to set the least Byass upon our Understandings; what we are to do, is impartially to follow Nature, without any regard to the Notions or Sentiments which may have possibly been entertain'd concerning it, tho' receiv'd with never so great a Commendation or Applause.

*Truth, without any respect to the Opinions or Authority of others, to be entirely pursu'd by us.*

§. 2. It has been before acknowledg'd, that our Perceptions exist, such as they are apprehended by the Mind, with all their peculiar Characters and Distinctions, since nothing can be more evident than that our Perceptions are themselves, and not any thing else than what they are; from whence it is likewise certain that our Sensations, or our Perceptions

*The Existence of Things without us not necessary to prove that this World exists.*

tions of those Beings, which are call'd External, have an absolute and undoubted Existence too, thus it is as plain that we have a Perception of the Sun, and of some Distance or other, which lies betwixt ourselves and it, as it is manifest that we think; supposing then no more than this were demonstrable, namely that the World, which has been hitherto esteem'd External to us, is not so in reality, but is painted however, and drawn out upon the Mind in all its true Lineaments and Proportions, as much as if it had been existing without us, it will follow upon this Concession only, that all Nature do's truly and actually exist, and that our Reasonings concerning it may be just, and far from the imputation of False and Chimerical; for it do's not enter into the Nature of real Existence in what manner, or which way, or from what Causes a thing exists, and if the Universe, and all the Furniture and Beings contain'd in it, are in our Perceptions, and our Perceptions are not imaginary but real, as hath been prov'd, Nature will as truly exist and be no more a Dream, than if it existed without us, and independent and separate from us; 'tis true we shall have been under a Mistake in attributing our Perceptions to wrong Causes, and making Nature and our Perceptions upon that account different; but this will not any way stake off from Nature's existing where it do's exist, because it may not possibly exist where we thought it did, nor will the Effect, which is certain and apparent, be less real, because referr'd to a Cause that is not so.

Thus, for Instance, let us take that Perception we have of Distance or the Sun, whatsoever is the Cause, those Perceptions exist within us, and may as truly be term'd a real existing Nature, from being and existing in our Perceptions, as they could have been had they deriv'd their Nature from something else, and we may as justly reason upon them; for we may as well say a Triangle is not a Square, or the Light of the Sun is not the Heat of it, whether  
these



These Affections and Properties are existing without us, or are only Distinctions in the Perceptions which we have of them in our own Minds.

§. 3. What has been alledg'd in the foregoing Section is only to shew, that our Reasonings upon Nature are not to be thought imaginary, neither is Nature it self to be accounted so, tho' all were resolv'd into our Perceptions, since our Perceptions have a real Existence, and are as justly entitled to the Being call'd and esteem'd Nature, as any thing that can be suppos'd external to us; and the Reason wherefore in such a Case the World might seem to be imaginary, is, beause we had refer'd this Nature in our Minds to something without us, which upon the present Supposition would be only indeed an Imagination.

*Our Reasonings in Philosophy not Chimerical, altho' nothing should be suppos'd to exist without us.*

§. 4. However, notwithstanding this may be offer'd against those Philosophers, who take a sort of pleasure in unsettling the first Principles and Foundations of a Science that is truly Great and Noble, and as capable of Demonstration as the Mathematicks themselves; yet we shall not determine our Inquiries here, but examine whether there are not Arguments sufficient to convince us, that what is conceiv'd to exist without us, really do's so.

*The two last Sections are argu'd upon the worst Supposition the Scepticks can make,*

§. 5. The Question then is, Whether that thinking, Perceptive Being within us, is capable of furnishing us with all those Sensations, which we are thought to receive from External Objects: In examining of which, since what is apprehended to be external to us, do's necessarily include a Perception of Distance from us; the first and most Natural Inquiry will be, Whether the Mind consider'd as a Being endued with Thought and Perception, can form to it self a Notion of Distance; if it can, then tho' Objects appear to be distant to us, it is not from thence certain that they are external; but if it cannot, as we shall endeavour to make evident, it must by the most infallible Consequence, receive that

*No reason to doubt of an External Being, because the Perception of Distance cannot be produc'd by the Mind alone, since it do's not any ways infer it.*

that Impression from something which lies out of it; but what Affinity is there betwixt Distance and Perception? we perceive, we reason, and judge, and we likewise find a succession in our Thoughts, and that there is a kind of Interval betwixt them, notwithstanding all this could ever give us the least Conception of what we mean by Distance, or the Remoteness of one thing from another; this is evident from a bare Reflection upon the Perception we have of Thought, and that which we have of Distance, which are as distinguishable in our Minds, as our Perceptions of Solidity and Colour, and we may as well be suppos'd to deduce the last from the former, or Colour from Solidity, as our Perception of Distance from our Perception of Perception.

*A Perception of Distance not produc'd by the Mind alone, because it is variable in different Circumstances, where the Mind continues the same.*

§. 6. It is farther very plain and obvious in Experience, that one who has fully confirm'd and settl'd in his Mind a Notion of Distance, from that Measure he has taken of one Object from another by his Sight, that the same Person, without his Sight by the Force of his own Mind, cannot describe that Distance; thus let us take never so exact a Survey of the Distance betwixt one Body and another, it will be found impossible for us blindfold to measure out the same Space: But if the Mind has a true Conception of Space from it self, it could not be mistaken in its Judgments and Apprehensions about it, Space would be one constant and uniform Impression, and there would be no Difference whether we took our Measures of it from our Sight or Feeling; and in general when we feel Distance in a Body, it is as different from our Seeing it, as our Sense of Feeling is from that of Seeing.

§. 6. As therefore from Seeing any certain portion of Distance, we cannot prescribe what it would be to our Feeling of it; so on the contrary, it is not probable that we should know from Feeling what a determin'd Space or Distance would be to our Sight; however it is not from hence consequent that one

*The Problem of the Globe and Cube, and that there is no Connection betwixt the Perceptions*

who is blind, and has learn'd by Feeling only to distinguish betwixt a Globe and a Cube, should not upon the receiving of his Sight tell the one from the other; which he undoubtedly may, if the Eye is suppos'd not to be steddily and fixt in a certain place, but to traverse the Figures by a Local Motion, as the Hand is imagin'd to do; because our Eyes turning, to view them in the last Case, would follow the same Direction with our Hand in the first, and tho' there is no Connection betwixt the Perceptions of one Sense and the other; yet the Motion of the Eye with that of the Hand, being correspondent, might lead us unto the Information.

of different  
Senses.

Lock's Essay,  
Ch. 9. B. 2. §. 8.

We have here affirm'd, That there is no Connection betwixt the Perceptions, which are deriv'd into our Minds from different Senses, which some, with whom I have convers'd, have thought may be done, for the same reason that we receive different Perceptions by the same Sense; whereas on the contrary, if the Mind and the Organ of Sensation continuing the same, our Perceptions are vary'd as the Impressions from without are chang'd, it is equally necessary the Mind and the Impressions from without continuing the same, and the Organ being chang'd, that our Perceptions should be likewise vary'd; since the Organ of Sensation, in the one Case, would produce the same alteration in the Mind, as the external Object in the other, if the Conformation of our Organs of Sight, Smell, Taste, Feeling and Hearing, are as different as any external Objects we can mention, which no one will, I presume, refuse to acknowledge.

Lock's Essay,

Ch. 5. B. 2.

Ch. 7. B. 2.

§. 8. If what has been said in the 6<sup>th</sup> Sect. do's not carry a sufficient Conviction with it, let us now suppose a Person wholly devoid of Motion and Sight, and every other Sense, except Feeling, to think in a certain place, it is manifest he can have no other Notion of Distance, unless that which he receives from finding his Body to exist. Let us still contract this Thinking Being, in respect of

A Perception  
of Distance not  
by the Mind  
alone, unless  
some Distance  
can be produc'd  
from none at  
all.



its Actual Sensation of Distance, and imagine it to perceive only in one single Point, without ever moving out of it; if the Mind could in such circumstances come to know what Length or Distance is, it might at the same time form a Conception of Length from no Length, or of a Line from a Mathematical Point; or, which is still the same, of the Motion and Progress of that Point, from its continuing fixt and immoveable; all which seems to be impossible, since all this must be done if the Mind, whilst it thinks in a Point, can by its own force exert it self into an actual Perception of more than that point in relation to Distance.

*If a Perception of Distance can be produc'd by the Mind alone, there is the same Reason to affirm that Colours may.*

§. 9. If the Mind, by the Dint of its own Perception, consider'd abstractedly from every thing else, but that which it is, has a Power of stretching, and as it were drawing out it self into a Perception of Length, without experiencing at any time what Length or Distance is; let us farther see, whether there is not the same Reason to affirm, that it has likewise a Faculty of representing Colours to it without any foreign assistance, which it is certain from what is fully attested by those who have been blind from their Infancy, it is not in its power to do; and which alone is a sufficient Argument to confute this pretence, that things may possibly not exist without us. I am not unacquainted with a very Ingenious Person, who has labour'd under this Misfortune almost from his very Birth, and yet, which will appear strange, is a perfect Master of all the abstrusest parts in *Philosophy* and the *Mathematicks*; whether in the *Algebraick*, the *Fluxionary*, or the *Geometrick* way; who has assur'd me, that he has no other Sensation from his Optick Nerves, nor knows no other in his Mind, in respect of Colours, than what he receives from any different parts, which only supply him with the plain Sense of Feeling: And if one small Digression will be allow'd me, I can never reflect upon the Circumstances of this Learned



Man, without recollecting that Passage in the *Tusculan Questions*, where *Cicero* gives that Famous Character of his Master; *Diodotus Stoicus cecus* Cic. *Tusc. Qu.* *multos annos nostra domi vixit. Is verò, quod credi-* Lib. 5.  
*bile vix esset, cum in Philosophiâ multo etiam magis*  
*assiduè quam antea versaretur, & cum fidibus Pytha-*  
*goræorum more uteretur, cum ei libri noctes & dies*  
*legerentur, quibus in studiis oculis non egebat, tum*  
*quod sine oculis fieri posse vix videtur, Geometria mu-*  
*nus tuebatur, verbis præcipiens discipulis unde, quò,*  
*quamque lineam ducerent.*

§. 10. But if Colours, and so indeed we may say of Sounds, and Tasts, and Smell, if they cannot be deriv'd into the Mind by its own Force and Energy, as it is Matter of Fact they cannot, it is every whit as evident that Distance can't; for supposing besides the absence of our Sight, Hearing, &c. all the Avenues of Sense were now stop'd to the Mind, or a kind of dead Numbness had overspread our whole Bodies, it is as plain that we could not have any Sensation of Feeling from them, as it is that a Man that is blind, cannot have that of Colours from his Eyes; but it is likewise as manifest in the present Case, if those Avenues were open'd, that we have a Perception of Distance by Feeling, and no Perception of Distance without Feeling, if obstructed, as that we have the Sense of Colours by our Sight, and none without it; and consequently from hence may be deduc'd this general Argument for things existing external to us, consider'd as thinking perceiving Beings; That since Colours are gain'd to the Mind by Sight, and Distance by Feeling, in the Circumstances we have put, and may be absent from the Mind, if those Sensations are, and which by its own Force it cannot introduce, it is certain there must be some external Power independent from the Mind, which do's impress them.

*A Perception of Distance produc'd in our Minds from our Organs of Feeling, as well as Colours, Smells, and Tasts, from our other Senses.*

*Our Perception  
of Distance,  
of Feeling, the  
Foundation of  
our Knowledge  
in the abstrusest  
parts of Learn-  
ing.*

§. 11. From the last Section an account may be given how one, who never remembers he had the least use of Sight, as in the famous Instance we have mention'd, should be equally or rather more capable, with one who enjoys it, of all the parts of Mathematicks, since that Notion which we have of Distance, and the several Proportions of it, lies originally in our Sense of Feeling, in which our Sight seems to be no farther assistant than in taking Marks, and treasuring them up in the Mind, of several Distances, which have been set out to us, by the Information of that Sense, which, however it has been hitherto term'd gross and undistinguishing, is undoubtedly the noblest Perception which we have; for whereas others by obliging and entertaining us with the Agreeableness of the Images which they offer to the Mind, do, as it were, charm and allure our Thoughts from the pursuit of Reason, to which pleasure, they give us, the advantage of their Character is chiefly owing; This in a manner furnishes us with all the Materials of solid Truth, and laies the Foundation of most of our Reasonings upon external Nature, without any such Baits to divert and entice us from them. In which Contrivance of our Beings, is visible the infinite Wisdom of our Creator; that tho' a hundred Casualties may deprive us of what may contribute to a Happiness from our Senses, there is nothing in the whole course of our Lives, which can rob us of what is essential to our Reasoning upon them, our Feeling; and the true Pleasures and Exstasies we experience from a Rational Enjoyment.

*The Argument  
pursu'd of a  
Perception of  
Distance, being  
produc'd in our  
Minds from  
our Organs of  
Feeling.*

§. 12. We have said before, that our Perception of Length or Distance, supposing, at least, our other Organs indispos'd, was owing to our Sense of Feeling, which must be either by means of our Bodies themselves, which communicate to the Mind several Impressions from distant parts of them, or which

is all one, by means of the Motion of the same part of our own Body to distant parts of others: And this seems fully evident from what we experience, since if the extreme parts, which belong to us, should undergo a gradual mortification, our actual Perception of Distance or Length is in proportion gradually contracted, and we might as well conceive our Arm, or any other part of us twice as long as it is by our Sensation; as imagine our Arm to be extended in our real Perceptions to its whole Length, where one half of it is perfectly mortify'd, seeing the No-sensation which the Mind has under such a mortification, is the same as a proportionable Length of Space, which do's not appertain to us, and consequently raises no Sensation in our Minds.

We speak of our real Perception of Distance, for that which the Mind has by its power of Multiplying or Remembling any determin'd Length, do's not at present enter into the Inquiry, which Powers the Mind can equally employ in relation to Colours, when a Person has been for some time blind, tho' it is own'd Colours are not to be obtain'd without our actual Seeing; If therefore the Actual Perception of Colours, and not the Remembling or Compounding them, is that which is the Cause and Origine of them in the Mind, the Actual Perception of Distance, and not the Remembling or Compounding of it, must be the true Source and Fountain of it likewise.

§. 13. From the last Section it is plain, that by diminishing our real Perception of Distance, our real Perception it self is no way impair'd, and that our Perception of an Inch, is as vigorous and strong as that of a greater Measure, and that therefore the Nature of the Mind do's not consist in the Perception of Magnitude or Quantity, but in the Quantity and Force of Perception, which may be as great in a Point as in the largest Space we can imagine; and it is farther evident that the Mind

*The Mind do's not consist in a Perception of Quantity, but in a Quantity of Perception,*

may think and perceive, abstracted from any thing without it, by its own Energy, and therefore that the Soul is immaterial, or not always annex'd to Matter, when it perceives; and for the same Reason that Matter diminish'd to a point will still be Matter; as also that it can be conversant about Immaterial Objects, originally without depending upon external Beings for the Subject of its Knowledge or Reasoning; But this we shall reserve for our Essay upon the Mind, which we shall endeavour to reduce to what we may not improperly call a *Psycheometria*, as we shall the present *Philosophy*, to the Reasons and Proportions of *Geometry*.

*Objection, that we have suppos'd all along what should have been proved, answer'd.*

§. 14. But if after all it should be possibly alledg'd, that the Arguments we have hitherto brought, for the Existence of an External Nature, supposes the Mind to consist in Perception, and then proves that every thing else must be foreign to it; if any one thinks that is suppos'd, we will therefore suppose the contrary, that Perception do's not only belong to the Mind but Distance, and Colours also, *i. e.* that the Definition of a Mind is, that it perceives, that it has a Notion of Distance and Colours, and it is impossible it should be without them; for if it may, then the Mind has sometimes one Nature, and sometimes another, it is a wandering Term, and signifies just nothing; if not, it has been evidenc'd to the contrary from our Experience in Colours, and from a parallel Arguing in respect of Distance, that the Mind on the one hand in Fact is, and on the other may be, without them.

*The Mind must be consider'd as a Thinking or an Extended being, neither of which will produce Distance, and*

§. 15. This we say, upon the largest Concession, for if the Perceptions of Distance and Colours cannot be produc'd in the Mind, consider'd as a thinking perceptive Being, they cannot be tho' we consider it under any other Capacity, unless of a Being perceptive of something differing from it self; our Perceptions, which have been already evinc'd to be true, are either those



those of Perception or Distance, Colours, &c. Distance, Colours and the rest must therefore either be introduc'd into the Mind, consider'd as a simple perceptive Being, or as a colour'd and extended, the first is deny'd, and has been refuted at large; If the second is affirm'd, Colour and Distance is granted to exist in the very Intention of denying it, not to mention the Absurdities of supposing Colour to be introduc'd into Colour, and Extension into Extension, and disallowing 'em to be Perceptions when we are sensible they are; and there remains only this last, that they are convey'd into the Mind, consider'd as a Being perceptive of Colour and Distance, external to the Being which perceives them, since, if they are internal and Perceptions themselves, then they are in the Mind, according to the first Case, and owe their Existence to a simple perceptive Faculty, which, as has been said, is not, nor cannot be defended; if they are not Perceptions themselves, they are in the Mind, according to Case the second, and draw the several Absurdities of it after them, which are consequent upon such a Supposition.

§. 16. Besides what has been offer'd to prove the real Existence of something external to us, we may farther observe in our Perceptions, from which, as being evidenc'd, we shall at present only argue, that there is as manifest a Distinction betwixt our Perceptions from the Mind, and those which are presum'd to be imprinted on it from Objects without us, as can well be suppos'd betwixt any kind of Perceptions we have; for Instance, let any one view or feel an Object, as Fire, and lodge it in his Memory, and then compare the actual Perception he has of such an Object with that which he perceives he remembers, he will find the Remembrance of that Brightness or Pain stands in no Comparison with the real Perceptions he had of them, but what we recollect will be acknowledg'd to be owing

therefore is a Being perceptive of Distance or Extension.

A manifest Distinction betwixt our Perceptions from the Mind, and from external Objects, where the Perceptions are of the same kind.

ing to the Mind, and consequently any Difference in the Perception of the same Object, from what the Mind perceives it from it self, must arise from a different Cause, and therefore external to it.

If we say that likewise in a Dream, as well as in our Sensations, we have a different Perception of Light and Heat from that with which our bare Memory or our Mind supplies us, or if we say that Memory it self is beholden to something external to our Perceptions; that Concession is made we contend for, since we do not inquire into the particular Causes of our Perceptions, only affirm that different Perceptions of the same suppos'd Object cannot flow from the same Individual Principle, which is little less than a plain Axiom, if we allow the Mind to be such a Principle, and if not, it is not any thing certain, but what we please to make it; against which kind of vagrant and indetermin'd Notions as there is no disputing, so it is as evident there is no defending them.

*Altho' the Perceptions from Memory, and from things which are suppos'd to exist without us were the same, they yet would proceed from different Causes.*

§. 17. Albeit there appears to be sufficient Evidence for us to be assur'd, that there is a Nature external to our own, yet that we may not be wanting still farther to confute, if possible, an Opinion which aims at the very Foundations of Philosophy, there is another Reason at least to acquiesce in what has been produc'd upon this Argument; which is, that albeit the Perceptions of Memory and our Sensations were the same in the Mind, yet by our Wills we can exclude and shut out of our Minds those Perceptions, which are offer'd to us from our Memory, and yet cannot, if we would, avoid the like Perceptions when impress'd upon us by our Senses; thus if we take the same Object, as this Paper, for Example, which we write on, whilst our Eyes are open, it is impossible for us not to see it, or to take our Minds off of it, whereas on the contrary when our Eyes are shut and the same Perception is resign'd to our Memories, it is with pains

pains and difficulty that we keep it in view, our Thoughts immediately turn to other Perceptions almost of themselves, and are ready upon the least command of the Will to leave the faint and languid Impression; But if the Mind, when it represents an Object to it self, is less affected than when it receives the same Object from what is thought external to us, since the Mind is the same which perceives both Representations, the Beings whose Representations they are, must be different, and if one is the Mind, the other must be something distinct from it.

If it be again urg'd, that the Memory do's not depend upon the Mind, but upon certain Animal Spirits, which do not belong to it, that is granted, which we have been endeavouring to prove, if it do's depend upon the Mind, the foregoing Argument will still obtain.

§. 18. Another proof of things existing independent of us, is, that when we reflect upon our Minds, we find our Perceptions observe a sort of succession, that they take their turns one after another in our Understandings, and it is impossible for us to contemplate two Things in the same Instant of Perception; thus if we consider what Pain is, we cannot at that very time that we are viewing that Perception in our Mind, consider what Colour is, or Light, or Heat; and it is the same, if we instance in Perceptions that are more compounded, as that of a Landskip, or a hundred or a million, *i. e.* the Mind can only represent one Object to its self at once, tho' it has the power of making its own choice, and changing it into another every minute; which is no more than that the Mind cannot represent any thing to its self without a Determination of the Will, and consequently since a fresh Determination is requisite, where we consider a new Perception, there must be evidently a Succession in those Perceptions; on the other hand, we can see the Light, feel the Heat, and,

*Another Argument for External Beings, is, that the Mind consider'd in its self, can only furnish us with one Perception at once, whereas it is experienc'd that it is capable of several Impressions in the same instant of time.*

and, if we please, the Pain too of the Fire, all at once; and, which is still more, think of any other Subject at the same time that we perceive those Impressions, without any new Determination of the Will; The Mind, consider'd as a perceptive Being, cannot do this of it self, and yet it is done, and therefore must be owing to a foreign Cause; since it seems to be impossible that any Principle, as that of the Mind, should by one Act cause at the same time two different Effects or Perceptions.

If, as before, it be alledg'd, that we suppose a perceptive Being what we define it to be, and then exclude all other properties out of that Definition, whereas it is not certain but this perceptive Being may receive several Impressions at the same time, as well as determine it self to one, we answer, that we will therefore admit the Property before mention'd to be a part of the same Individual perceptive Being, if so, it can receive different Perceptions at the same time, by its own Powers and Faculties, and yet, as a perceptive Being, by its own Powers and Faculties it cannot do it, according to what is alledg'd in the beginning of the present Section, which is as much as to affirm, that this perceptive Being is it self, and yet different from it self; which how we can reconcile, unless by distinguishing it into two several Beings, the Perceptive and the Perceiv'd, which we had falsly joyn'd and united into one, will not be easily imagin'd.

If farther it is said, that involuntary Perceptions may rise in the Mind at the same time that we are thinking of something else, we answer, that such Ideas would call off our Attention to what we had in view before, and therefore will not exist in our Perceptions at once, with that which they exclude from them, which is not the Case of outward Objects; for involuntary Perceptions, which rise in the Mind, are either immediately embrac'd or



rejected, and are after their appearance directed by the Will; whereas those from external Objects are not.

§. 19. Besides this, it is to be confess'd that we have no Argument for our perceiving or existing, unless our Consciousness of it, which is an invincible one, as those who will not allow an External Nature demonstrable, are ready to acknowledge; but into the Consciousness of our Perception enters the Consciousness of the place where we perceive, otherwise we might think we perceiv'd here, for Instance; when that Perception is in another place distant from our selves, and consequently not the Perception of that Being which we call our self, and I *think*, therefore *I am*, is no good Argument, since I who am here may think, and that Thought may not be here, nor that which is concluded from it. From hence then it evidently follows, that if our Consciousness to our perceiving in a place, is a proof that we exist in that place, our Consciousness to our perceiving something in another place, is a proof that the Causes of those Perceptions do exist in a different place from our selves; nor do's this Argument lead us to fix Objects always in the same place in which we perceive them; all that it proves is, that by the same Reason there is something within us, there is something likewise External to us; but when we have once advanced one step from our selves, it will be easy to account how different Distances may cause the same Impressions upon our Minds, or how those which are the same may occasion different, as we shall afterwards shew, and which is all that can be oppos'd to this Demonstration.

§. 20. The last thing we shall mention on this Head, is the difference betwixt an Absolute, and what I would call for distinction a Relative Perception: An Absolute Perception is no other than self, which has been explain'd in the first Chap. and only respects the Mind, as a perceptive Being;

*Our Consciousness that we perceive something distinct from us, as much an Argument that there is something exists agreeable to that Consciousness, as our being conscious of our own Existence, is a Proof of it.*

*The Reference which the Mind makes in its Sensations, a Proof that they are not originally deriv'd*

*from the same  
Source, as its  
absolute Per-  
ceptions are.*

A Relative Perception is when the Mind refers it self to something besides its own Perception; if therefore all our Sensations lay in the Mind, as Archetypes or Original Perceptions, they would terminate in themselves, as our Absolute Perceptions do, and a Relation would be altogether impossible; thus if I think or perceive that Perception is incapable of being Related to any thing, as the Image and Resemblance of it, seeing it is expressive of nothing but its own Identity: But the same cannot be said of our Sensations, in which it is as manifest that the Mind do's compare its Perceptions to a certain kind of Archetypes, whatever they are, as it is that it has those Perceptions; which how it should do, if there was an exact Identity betwixt the Perception and the suppos'd Archetype, to which it is referr'd, is not to be conceiv'd; and yet such an Identity is presum'd, if our Perceptions of Sense arise from, and are limited, and concluded within the Mind, which is a certain Argument that Beings do exist without us, and are the Foundation and Cause of these Relations.

### CHAP. III.

*Concerning the Objections alledg'd against  
the certainty of External Nature, and the  
Confutation of them.*

*Arguments for  
a Truth seldom  
so important  
with us, as Ob-  
jections against  
one.*

§. I. **T**HO' what has been said, in the former Chapter, might satisfy us, that there is something existing external to our Minds, yet since it is observable, that one Objection against a Truth is apt to weigh more with us than several Arguments brought to establish it, it will not be any ways improper to examine upon what accounts, and on what pretences of Reason, we are made to doubt

doubt of a Proposition, which is surrounded with such Evidence, that it seems almost a Reproach to our Understandings to question the certainty of it.

The Objections against it, however, have been apprehended to carry such an invincible Force with them, that one who would not admit of the abundant Caution they prescribe, would be thought to take his Philosophy, as it is given him in gross, and to purchase his Knowledge with his Credulity.

§. 2. And First, it is objected that we perceive Colours, Smells, Tasts, Sounds, Heat, Pain, and all those sensible Qualities which are call'd Accidental in Bodies, as if they really existed in the Objects themselves, which are not in truth any where but in our Perceptions; and if so, why may we not say the same of Existence? To which we reply, that the rise of this Cavil is grounded upon a very fundamental Mistake, which has insinuated it self into most of the Modern Philosophy, since we do not perceive Colours and Sounds, for example, as if they really existed in the Objects themselves, in that Sense and Notion which this Objection and the Authors of it affix to them, seeing what they mean by Sounds, or Colours, or Pain, is our Perceptions of them; that is, the Pain we feel, or the Colour we see, or the Sound we hear, is in our Minds, and not in the Needle or the Tapestry, or the sonorous Body; which however it might be advanced to amuse us, and to make us think there were some mighty Secrets in Nature, which had not yet been discover'd, amounts to no more than that our Perceptions are not without us, but within us; that they are not in the Bodies we contemplate, but in the Mind that contemplates them; and in this Definition of Colours, and the other Accidental Qualities of Body, there was no one ever imagin'd them to reside any where but in our selves; there is not any one that will affirm or ever did, that a Needle felt Pain, or a Fire Heat, that a sonorous Body heard

*Colours, and the other Qualities of Bodies, as they ly in the Mind, never suppos'd to exist without us, and therefore no Argument that these Qualities in truth may not exist without us, when they really do not, nor cannot ly in the Mind.*

*Recherche de la Verité. Tom. 2. p. 351. 352. Cartes's Meditation 6. p. 48.*

heard it self, or that Red or Blue saw its own Colour, which is all that is intended when we say, that Blue or Red, or Sound or Pain, are not in external Objects, *i. e.* the Perceptions of them are not.

But because our Perceptions are not in the Qualities of Bodies which are perceiv'd, it do's not therefore follow, that there is no Reason or Occasion in those Bodies of our Perceptions, or, which is the same, that those Qualities are not perceiv'd, if it be really a true Consequence, then we ourselves have no perceptions of them, much less have the Qualities which are suppos'd to produce them. The whole therefore of the present Objection comes to this Issue, that our Perceptions are distinct from the Qualities of Bodies which are perceiv'd, or they are not; if they are not, then Colour, and Pain, and Sound, by what has been already said, when consider'd as Perceptions, are the same as Colour, Pain and Sound, which are not Perceptions, that is, Perception and Non-perception are alike; if they are distinct, they are in truth somewhere else than in our Perceptions, the contrary of which is affirm'd in this Objection; and indeed such is the Fate of bad arguing, that what is here offer'd to oppose the Existence of Things without us, in Fact affirms them to exist, and only proves that we may possibly be in the Wrong in our Reasonings or Judgments on them, which is not an Argument against the Fallibleness of our Senses, but of our Understandings, and our Conclusions from thence.

For where the Objection affirms, that Heat or Pain is not in the Fire, but in the Mind, it at the same time acknowledges External Being, whilst it contradicts it; since if Heat and Pain are in the Mind, without the opposition of not being in the Fire, the Foundation of the present Objection ceases, which supposes that Heat and Pain are not  
in



in the Fire but in the Mind, and from thence concludes our being deceiv'd, in imagining Things to exist, where they really are not; and consequently that the same may be the Case of External Nature; for if there were no Opposition betwixt our perceiving Heat in the Fire and in our own Minds, how could we be said not to perceive the Heat where it really is? On the contrary, if there is an Opposition made betwixt the Mind and the Fire, and betwixt our perceiving Things in one place when they exist in another, it is an evident Confession of something external to us in the very Argument which is us'd to render us uncertain of it.

§. 3. Upon this Principle, which we have endeavour'd to refute in the foregoing Section, is that Opinion in part founded, that there is no Connection betwixt our Perceptions, and the real Existence of Things without us, since tho' we perceive Colours, or Sound or Heat, for Example, it is not necessary they should exist, because our Knowledge can extend no farther than our Perceptions; on the contrary, we say Colours, &c. do exist, and where we perceive them to exist, not our Perceptions of them, which are in the Mind, and is only one Definition of Colours, &c. but the Reason and Cause of our perceiving them, exist, where we have Reason and Cause to perceive them, which is as necessary to our Perception of 'em, and enters as much into the Nature of it, as our Mind that perceives; for tho' our Perceptions are not in the real Qualities which we perceive, and that is all that is prov'd in this Doctrine, yet it is not therefore consequent that those real Qualities are not so far in our Perception, as to be essential to our perceiving them; We own Colours, &c. is not in Bodies, if we mean by Colour that Perception of it which is in the Mind, neither on the contrary is Colour in the Mind, if we mean by Colour that real Quality which is in Body; which in both Cases is only to affirm, that

*The Argument from there being no Connection betwixt Perception in the Mind, and the things perceiv'd, refuted.*

*Mr. Raphson De Spatio Reali. p. 28. §. 6. Recherche de la Verité, ch. 10. liv. 1. pag. 70. 1 Tom. 1. Il n'y a point de Liaison, &c.*

Percep-

Perception is not Body, nor Body Perception: If therefore instead of the ambiguous Words of Colour, Sound, &c. we substitute Body and Perception, the Fallacy will easily appear, namely, because Perception is not Body, and Body is not Perception; therefore it is uncertain, whether there is any Body at all.

So that the Whole lies in this short Compass, There is no Connexion betwixt our Perceptions and the real Existence of Things, because Perception is not the Quality perceiv'd, which Argument, if it is conclusive, either 1<sup>st</sup> supposes, since one thing is not another, that therefore one thing do's not depend upon another; or since the Cause is not the Effect, that therefore there is no Dependance or Relation betwixt the Cause and the Effect; whereas on the contrary, if there is a Connexion or Relation betwixt our Perceptions and the Existence of the Qualities we perceive, or betwixt the Cause and the Effect, that Relation infers and concludes a Distinction betwixt them, which is the very Foundation of this Objection, that is, the Objection against External Nature is founded upon that Distinction betwixt the Cause and Effect, which must be certain, if there is an External Nature; Or else, it 2<sup>d</sup> supposes that there is nothing but Perception certain in the World, *i. e.* because the Quality perceiv'd is not Perception, therefore it is not certain it exists; but to suppose nothing certain in the World unless Perception, in an Argument that is brought to prove nothing certain in the World but Perception, is a new Way of Demonstration, and the easiest perhaps that has been yet invented. There is indeed another Foundation of this Scruple, to wit, of there being no Connexion betwixt our Perceptions and the Existence of the Things perceiv'd, which is the Power of the Mind in forming Perceptions, that are Chimerical, whether in Dreams or any other way. But this we shall consider under a different Head.

We confess this Argument is not directly us'd by the Excellent Person, to whom we in part refer in the present Section, to prove the Uncertainty of Things existing without us; but to evince the Inadequateness of our Knowledge, in respect of External Nature; on the other hand, if we cannot know any thing of the real properties of it, because they exist without us, and our Minds are not the Causes of, but are wholly distinct from them; by the same Reason it may be inferr'd, that we are not certain whether those Properties exist at all, independent of our Minds, because our Perceptions can reach no farther than themselves; But, as it has been already shewn, they may, so we shall now moreover evidence, that we may have as adequate a Knowledge of Beings existing without us, as we can have of our own Perceptions.

For it has been prov'd in this Section, that External Nature is the Cause of what is the Effect in Sensation; if therefore we know what the Effect is in the Mind, we may equally know what is the Cause which produc'd it from without; since if the Effect is known, that is, which way, or in what manner, the Mind is passive to External Impressions, it will be likewise manifest, which way, and in what manner, those External Impressions are active upon it; if we do not know what the effect is in the Mind, then our Sensations, as they ly in the Mind, are equally unintelligible to us with the External Causes which produce them.

Besides, to speak in general, the Mind cannot be more known to us than Body is, because by that is meant either the Essence or the Properties of each, the Essences of both are acknowledg'd to be equally unknown; and if so, the Properties which result from those particular Essences, must be too. For, moreover, if we take abstracted Perception in the Mind, we know it exists, but the Cause of its Existence, we are ignorant of, and this

is no other than what we experience in Body or External Nature, which we perceive exists by our Sensations from it; but what is the Cause of our perceiving it to exist, is likewise the Inquiry here, as before it was in our Perceptions deriv'd from the Mind.

Descartes Meditation 2<sup>d</sup>.

'Tis true, the Mind has been apprehended, by some late Philosophers, to be better known to us than Body, because, I suppose, we are certain we perceive, whereas it is not so certain that Things exist without us; but as we shall prove we have an equal Evidence of External Nature with that of our own Minds, the reality of the one is as infallible as the Existence of the other, and from the present Section, the Properties of Both are alike, either known or unknown to us; and in truth the Notion of the Mind's being more known to us than Body is, seems only to be deriv'd from that Sceptical part of Philosophy, which we are now confuting.

*The suppos'd Errors of our Senses in our judging of Figure, Motion, Distance, and Extension, no Objection against them.*

§. 4. The next Difficulty that is rais'd, and which has a near affinity with the foregoing, is, that in the Motion, Figure, and even the Extension of Bodies, our Senses often deceive us, and the Inference is, that therefore we are not to credit them in any respect whatsoever, and are to disbelieve, if it only rests upon their Testimony, Motion, Figure and Extension it self; Under this Objection all the most material Errors of our Senses ly, as in Vision, when through Multiplying Glasses one Object is represented as several, in reflecting Concave Glasses, when Objects appear before it that are not really there, or, which is the same, in plain Reflecting ones behind it, where there are no such real Images; thus likewise in Extension, an Inch may be magnify'd to a thousand times its Dimensions; in Figure, that which is a Rhombus may appear to us like a Square, or a Circle like a Globe; and in Motion, that which changes its Situation, to us



may be in effect quiescent; and therefore we cannot be certain of any Informations from our Senses, or that Bodies exist without us, since the chief properties of them, and which in a manner constitute their Essence, are, according to the Judgments which our Senses make, of so capricious and desultory a Nature; thus in Distance, that which appears to be only 3 or 4 Miles from us, may be many Millions; and if several Bodies are interpos'd, that which is near us may seem to be remov'd much farther from us than it is.

To assign the Reasons of these Varying Representations in the Mind, would abundantly confute this Objection, and shew that they are not Errors in the Senses, which would give us false Informations, if they affected us otherwise than they do; as, particularly, in respect of Concave Reflecting Glasses, if we did not see an Image coming out before it, in a certain position of the Eye, and curvature of the Glass, there would be a power of producing a Perception, in us without our perceiving it, that is a Cause without an Effect; and if our Senses did not inform us of those Causes or Powers, they would deceive us with a witness. But this is the Province of Philosophy, namely, to find out and determine these Causes, and therefore we shall leave that kind of Confutation to the Principles, which is the Design of the present System to advance.

§. 5. The Answer that we shall make to such sort of Pretences, is to what they all terminate in, that because our Perceptions are different from the things which are perceiv'd, therefore we have reason to think there is nothing else excepting our own Perceptions; or, at least, it is uncertain whether there is any thing more; which falls into the same Objection that has been already made, and which we shall still farther examine. Let us take that Perception which we have of the Distance of the Sun from the Earth, because therefore we do

*Recherche de la Verité, ch. 10. Liv. 1. P. 70, 71. Tom. 1. Eclaircissement sur Ch. 10. Tom. 2. & Ch. 5, 6, 7, 8. Liv. 1. Tom. 1. Cartes Med. 6. p. 44.*

*The Argument for our Uncertainty concerning things without us, depend upon our Certainty of their really existing without us.*

not see it at its real Distance, which is computed by Astronomers to be 54 Millions of Miles, the Conclusion is, that we cannot be certain whether there is any Distance at all betwixt them. This Argument then supposes a real Distance computed by Astronomers, which Computation if we deny, and affirm there is no other Distance than what is visible to our Sight, the very Foundation of our Doubting concerning the Existence of an External Nature is taken away; and consequently the Reason of our Uncertainty, in Relation to things without us, in the present Case, is built upon our Certainty of their being without us, than which nothing can be more preposterous or absurd.

*The Arguments against the trusting our Sensations are founded upon this false Principle, that Dissimilar Causes ought to produce Similar, and like Effects.*

§. 6. What has been said of Distance, may be equally apply'd to Figure, or any other Object, where the Perception is different from the real Existence of what we perceive, since in all these Cases some thing External to us is suppos'd, in order to prove, that there is nothing External to us; but that which still farther shews the Weakness of this way of Arguing, is, that it supposes our Perceptions ought to be the same, where the Impressions are different, and from thence infers, that it is uncertain whether there are any Impressions at all from External Objects; for, if we perceiv'd the real Distance of the Sun from us, that part of the Æther, which is several Diameters above us from the Earth, would affect us in the same manner, as that which more immediately strikes upon our Organs of Sensation, and there would be the same Effect from unlike Causes; and by a parallel Argument we should see the Sun at 54 Millions of Miles distance in the same Magnitude, as if it were only a Mile off us, Magnitude being no other than a Perception of Distance; but that which is alledg'd of Distance is easily conceiv'd to extend to Figure, as a Modification of it, and to the Images exhibited to us from Concave or Plain Glasses, where the rays of Light are under a

different Circumstance to the Eye, than they would be without their Intervention.

This therefore is suppos'd, in the present Objection, that tho' the Causes are different, the Effects ought to be the same, and from this new Maxim in Philosophy, it is as rationally concluded, that there are no Causes at all, namely, because there are, and which yet is more surprizing, because they are as they ought to be, that is, different in their Operations, when they are so in themselves, and in their own Nature and Constitutions.

§. 7. And indeed, in general, we may say that the Mind's not perceiving Things as they are, is no Reason why it should not perceive them, as it do's, which yet, in the last Result, is the Intent and scope of this sort of proving, that is to shew, or at least to make us believe, we have no Sensations, because we have some kind of ones, or in the shortest Expression, as before, to prove we have none, because we have.

*The Mind's not perceiving by its Sensations things as they are, no Argument that it do's not perceive them as all.*

§. 8. But that which the most nearly affects the Certainty of Things existing without us, is, what is produc'd on this Head by Philosophers, concerning those Appearances which are made in the Mind, where there is no evident Cause of them external to it; thus in Dreams we have very lively Representations of all manner of outward Objects, whereas it is plain, there are no such Objects which imprint them on us.

*The Dreams of Men in their Senses, and the strange Imaginations of others under a Distraction &c. the strongest Arguments against the certainty of External Beings.*

It is the same with Men, who are delirious, or under a Distraction, for these Persons likewise fancy, and do really apprehend they see those things, which are no where existing, except in their own Imaginations; some have thought themselves to be made of Glass, Butter, that they had Horns, others that they were Wolves, &c. and therefore it is thought we may possibly be Wolves, when we take our selves to be Men, as well as Madmen really Men, when they suppose themselves to be Wolves; since if all

Descartes Me- the World thought themselves Wolves, he that  
ditat. 1. P. 6. had thought he was a Man, would have been the  
Medit. 6. P. 45. Madman.

Recherche de  
la Verité, P.  
352, 353, 354.  
Tom. 2.

Add to this, that those who have lost an Arm, have felt a pain in the place where their Fingers us'd to be; when therefore we feel any thing by our Hands, how should we know whether it is not an Affection in the Mind, how is it certain that we have any Hands, since we may feel our Fingers, where in truth they are not; and the same may be said of any part of us, or Sensation that belongs to us.

These are the most important Objections that can be brought against the Certainty of Beings distinct from our selves, and the most directly Aim at the Subversion of all External Nature.

Where there is  
some sort of E-  
vidence on one  
side, to justify  
a Truth, and  
nothing certain  
that contra-  
dicts it, we  
ought to incline  
to the more pro-  
bable Hypo-  
thesis.

§. 9. But if we examine into them more exactly; they will not be so formidable as we are apt to think them; the Terrors of these Apparitions will soon vanish, and there will be nothing more than what we might expect from very Natural and Adequate Causes: The first Answer therefore we shall make, is, that if we allow the most which can be desir'd, these Objections are no Proof against things without us, or so much as a sufficient Reason for us to scruple or doubt of their Existence, since the same way by which we can infer that it is Uncertain there is any thing external to us, from a Supposition that Dreams, and those other Imaginary Appearances are absolute Creatures of the Mind, from another Supposition, which is as rational and as well attested as the former, namely, that they are not absolute Creatures of the Mind, may be deduc'd a quite contrary Conclusion; that therefore it is certain there are Beings exist independent of us.

Where then we have good and undoubted Arguments for the truth of any Proposition, as has been already shewn, we have for the Certainty of External Nature, and what is at present oppos'd to it,



it, rests upon an Affirmation, which, for all we know, may or may not be true; the Question is, Whether such an Affirmation ought to fall on the side of Demonstration, or this yield to the precarious Positions of the other, and I believe every Reasonable Man will be very much inclin'd to think the former.

§. 10. Let us now suppose that all those Perceptions, which are experienc'd by the Mind in Dreams, or a Distraction, or in the loss of an Arm, have their Rise and Foundation there; yet if they are perfectly different from those which are deriv'd into it from Sensation, such a Concession will be so far from proving that Objects do not exist without us, that it will be an Argument they do.

It is well known, that our calling different Perceptions by the same name, has been often the occasion of great and even the grossest Errors, which is true in the present Case; thus, when we recollect in our Minds those real Perceptions we once had of Heat, or Light, or Pain, we rank these Perceptions of our Memories under the same names as those others, which we had from Actual Sensation, and then presently conclude, they are in Fact the same; yet, I believe, the Mind will be found to be very differently affected, with the Heat it felt from the Fire, or the Pain from a Needle, than ever it was, or could be by remembering only those Perceptions; and the same is true of Distance, of the Sun, of an Animal, or any other Perceptions, when our Actual and Original ones are compar'd with those which the Mind retrieves by its own Power, and silently and with Pleasure, as well as of Choice, contemplates, albeit they were before impress'd by Force, and sometimes with Reluctance.

This indeed must be granted, that our Perceptions from the Memory do so far represent their Archetypes, that whenever we see the Archetypes themselves, we know them to be those of which

*The Difference of our Perceptions from Sensation and Memory, consider'd.*

we have the Pictures and Images in our Minds; but yet at the same time they are really as distinguishable from those Archetypes, as the Picture of an Animal, or the Sun from the Beings they resemble.

*The Perceptions in Dreams, or Deliriums, are of the same Nature with those of our Memories.*

§. 11. If it be so in the Perceptions of the Memory, as it most evidently is, there may be an easy Solution given of the rest, which do not depend immediately upon External Causes; for those we experience in Dreams, or, which are the Effects of a Delirium, are nothing else, unless that they are stronger, and more forcible in the Mind than the others, which are barely lodg'd in our Memories; but that they are of the same Nature, is plain in their being as fully distinguish'd from our Actual Sensations.

*Our Perceptions in Dreams, differ from those we receive in Sensation, and therefore no Argument against it.*

§. 12. In the preceding Section it is said, that those Perceptions we have in Dreams, are extremely different from our Actual Sensations; for though as in our Perceptions from the Memory, they are, as it were, Types and Symbols of what our Senses represent to us, yet that they are not such kind of Perceptions is evident, since, if we dream of the acutest Pain, as that of an intense Fire, or of the pricking of a Needle, the Mind is indeed affected, but not in that way or manner, as if those Pains were really apply'd to our Organs of Sensation from a Needle or the Fire; in the first Case we may perhaps be disturb'd and uneasy, and notwithstanding that continue dreaming, but in the last, the Mind is immediately rous'd into a Sense that there is something that afflicts it besides its own Fancies, and this in the deepest Slumbers that are capable of being introduc'd upon us; which shews, that what we dream of is only a Shadow, or a lively Figure and Portraiture in the Mind of that which is as different, when we come to feel or perceive it, as the Fire that is painted is from the Natural. For as by deep Study and Contemplation, or an Inactivity of the Mind,

Mind, in respect of its considering any other Perceptions, excepting those on which it is fully determin'd, we can raise our Ideas to a lively resemblance of their Originals; so in Sleep, where the Mind is perfectly undiverted by its own voluntary Thoughts, the same will likewise happen.

And in general, let any one dream of certain Objects, and compare them with the same Objects which he perceives when awake, and let it then be inquir'd, whether he has in every respect the same Notions and Apprehensions of them; if he has, he could not distinguish his being asleep from his being awake, since a Dream is made up of Perceptions, and the time we are awake is so too; both which Perceptions, if they are the same, it is certain could not be distinguish'd, which in Fact are: If he has not the like Apprehensions of both, the same things are differently perceiv'd by the Mind, and therefore are owing to the differing Causes of our Perceiving them; of which if one (in the Case before us) is granted to be the Mind, the other must be something foreign and extraneous to it.

§. 13. And this way of Reasoning equally extends to the other two Cases of Phrenzy, or the Loss of an Arm; the first of which is a kind of a Dream, as a Dream is but a sort of Memory, they certainly, at least, agree in this, that the Perceptions we receive in any of 'em, are perfectly distinguish'd from our real Sensations; for let us farther consider one under a Delirium, it is manifest that he can, and do's distinguish betwixt what he truly sees, and that which he has a strong Impression upon him that he sees; if any one imagins himself to be made of Glass, it is plain he has not the same Notion of that Glass, of which he supposes himself to consist, as he has of any other Glass which he feels and perceives; if he has, he feels himself brittle at the same time that he perceives his Limbs

*The Perceptions of Men Delirious, different from their Actual Sensations, and therefore no Argument against them.*

Limbs pliant and obedient to the Motions he prescribes them, he finds his Hand transparent, when he can see nothing through it; and, as to his Senses in general, he takes himself to have all the real properties of that Body, when he cannot by any Experience say he has one of 'em: From whence it is evident, that he do's not perceive himself Glasse, only has an Image or Representation of it strongly impress'd and struck upon his Mind, which yet is very different from the Perception or Sensation it self, and wants as much of its Perfection, as the Shadow falls short of the Substance.

That this is so, is likewise in some measure prov'd, from the Causes of such Fancies, which generally proceed either from Person's continually poring upon that which they afterwards imagine themselves to be, by which the Mind gets so entire a Picture of the thing, that it finds no difficulty in mistaking it for the Thing it self; or else from an extreme Liveliness in the Apprehension, which Madmen are known to have so far, that those who have been esteem'd before little better than Idiots, under a Distraction, have not been inferiour to Men of the sharpest and quickest Parts: But where Men's Apprehensions are the most lively, it seems to be necessary the Images that ly in the Mind should be brighter and clearer in proportion, and consequently it is not improbable, but those Perceptions of Things which appear faint and duskish to us, upon a bare Recollection, in a more brilliant State of our Perceptive Faculties, may put on a more forcible and a nearer Resemblance of the Things we recollect, and may seem to express them with more Life and Exactness; however, we cannot still but conclude, they are perceiv'd only as Draughts or Representations, and not as the Things themselves.

*The Perceptions  
of Men Deli-*

§. 14. We shall more easily conceive this, if we consider those Apparitions, which Men disorder'd



in their Heads, are presented with at such times, for they often very well know they are not what they seem, and therefore take them to be only Images, or Signatures of Beings, which the Mind, as it were, in Sport forms to it self, in imitation of Nature, and as in, so after a Phrenzy, a Person distinguishes as plainly betwixt the Impressions he had from it, and those which he receives from External Causes, as betwixt the Aëry Phantoms of a Dream, and the real and solid Informations of his Senses. From whence is confuted that wild Fancy in §. 8. that Men in their Wits may think they are Men, when yet they are Wolves in reality.

*rious being different from their Actual Sensations, no Argument against them farther explain'd.*

§. 15. 'Tis true, there are some Perceptions which seem to be of the same kind with those of Mad-men, and which every one more or less experiences, as a Ringing in the Ears, and Light and Colours in the Eye, which we can form and raise in our Minds, tho' the proper Inlet of 'em is clos'd; and these may be thought to have as much of Reality in them, as any of our Sensations whatsoever, but that they are very different, we may conclude from hence, since such Sounds and Colours have but a faint Resemblance of that which we truly see or hear, they are no other than flat and languid Imitations in the Mind, of what is strongly and forcibly impress'd on our Senses, as any one will easily acknowledge, who compares the one with the other, and is abundantly prov'd from the Impossibility in Persons who are born Blind, or Deaf, of raising such Perceptions in themselves.

*Imaginary Colours and Sounds, no Objection against our Sensations.*

§. 16. As to what concerns the Pains which are felt in the Fingers, upon the loss of an Arm, it is manifest they are distinct from those which are convey'd into the Mind, by a real Sensation from them, since if a Man were to put his Finger into the Fire, or pierce it with a Needle, or cut it with a Knife, the Perception he has from any of these Actions, will not be the same, as from the like Actions

*No Objection that Men who are maim'd feel a Pain in those parts which are lost to them.*

ons of Pain, which are impress'd upon the Nerves of the Arm which is maim'd, and are refer'd by the Mind to the extreme parts of it; there will be a sensible difference betwixt them, and the last, when consider'd in the same view, will appear, I believe, to be only a Transcript or Similitude of the former.

*The occasion of Error in the present Circumstance, is, that we confound two different Perceptions, by imposing the same Name on both.*

§. 17. This then is our Fault in these sort of Reasonings, that we are very apt to confound things, by imposing general Names upon them, which yet include very often different Perceptions; thus under the Word *Pain*, is comprehended several Sensations, which are as foreign to each other, as the Light of the Sun to its Heat, and from hence it is that we falsely argue for the possibility of Sensitive Pain, being produc'd by the sole power of the Mind, because the Mind may possibly excite in it self another kind of Pain, which is as different from the Sensitive, as a bare Uneasiness is, which is own'd to be a Creature of it.

To conclude, in general, by the same Argument, that we infer there may possibly be no Sensations from External Objects, because the Mind has a Faculty of producing Perceptions, that very nearly imitate and resemble them, but has not to produce the Sensations themselves; we may likewise prove that we have no Actual Perceptions of things without us, for the very Reason that we remember them, or, on the contrary, that because a Man can paint, he can therefore make a Sun.

*If the Mind can form of it self, the same Perceptions it has from Sensation, we are not certain our Sensations are true, but this it cannot do.*

§. 18. In fine, if the Perceptions we have in Dreams, or those which Men under a Distraction have, or which Persons experience either in the ringing of their Ears, or seeing imaginary Colours, when their Eyes are shut, or of Pain in their Fingers, when they have lost their Arm; If any of these Perceptions are really the same, if they are in no respect distinguishable from the Sensations we receive from External Objects, and are deriv'd from the Mind, we cannot but confess it is uncertain whether

whether any thing exists without us or not; since, if it is in the power of the Mind to form the very same Perceptions, which are thought to be deriv'd into it from External Agents, it is not sure that all our Perceptions, are not from the Mind, without any other Assistance; but if on the contrary, in all the Instances which can be brought of the Mind's perceiving, from it self, its own Perceptions are different, if we regard the same thing, from what it is supply'd with otherways, the Case is evident and plain, that there is something more than the Mind, which is the Cause of those Perceptions, and this has been endeavour'd to be prov'd in the foregoing Sections.

§. 19. Again, if, on the other side, these Per-  
ceptions in Dreams, &c. are the very same in Na-  
ture and Essence with our ordinary Sensations, to  
make this an Argument against the Certainty of  
the Existence of Corporeal Beings, it must be pre-  
sum'd, that our Perceptions in Dreams, or a Distrac-  
tion, are struck and drawn out from the Mind by  
its own power, and consequently those we call our  
Sensations, may be, the contrary of which we  
might assert with as good or better Evidence,  
namely, that our Sensations are communicated to  
the Mind from something External to it, and  
therefore those Perceptions we have in Dreams, or  
a Distraction are so too; for why we should argue  
from the Nature of those Perceptions we have in  
Dreams, to the Ascertaining that of our Sensations,  
rather than from our Sensations, to the Ascertaining  
the Nature of those Perceptions we have in  
Dreams, will be difficult to say, unless we have  
a much clearer Knowledge of what passes in our  
Dreams or in a Distraction, and the Causes of both,  
than we have of our common and constant Per-  
ceptions, which would not be much to the credit  
of his Senses, or his being awake, if any one should  
affirm.

*If our Perceptions in Dreams, and our Sensations were the same, there is no more Reason to assert that our Sensations are Dreams, than these the contrary.*

§. 20. But



*Our Perceptions in Dreams and Deliriums are not to be entirely ascribed to the Mind, for what Reason.*

§. 20. But that Dreams and Deliriums, and the Sensations we have in those places, where formerly our Hands or Fingers existed, are not entirely to be attributed to the Mind, is evident from hence, that a Person in his Wits, or who is awake, or is not maim'd, cannot by all the Force of his Faculties raise those Perceptions in himself, which are experienc'd in the foremention'd Cases; if therefore the Mind has one and the same Nature, it would be impossible for it, without some External Powers, to do that at one time, which at another it was wholly incapable of; if it has not the same Essential Invariable Properties, its Essence is different from it self, i. e. it is nothing but a Word, without any determin'd Sense or Meaning.

*'Tis falsely presum'd that our Perceptions, in Dreams and Deliriums, arise from the Mind: The Reason.*

§. 21. Besides this, we may add, that the Reasonings from the Instances alledg'd, is not just upon another Account, for it depends upon a second false Presumption, that since those Objects which are presented to us in Dreams, &c. are not owing to any External Causes, separate and distinct from our selves, therefore, their Original is in the Mind; whereas if they are introduc'd into the Mind by the Mediation and Intervention of any Organs of our Sense External to it, there will be equally a proof of something existing out of, and independent of our Understandings; and if it be once evidenc'd, that one parcel of Matter, which is in a due Disposition to the Mind, can produce Sensation in us, as our Organs, for Example, to exclude all other parcels of Matter, which, in External Objects, as will be afterwards shewn, have a like Disposition, is unreasonable, and no ways agreeable to a true Philosophy.

But this will carry us on to the Nature of that Union, which there is betwixt the Soul and Corporeal Beings, and which deserves a distinct Chapter by it self, on account of the Importance of the Subject; what we have said in this Section already, is sufficient to evacuate and supersede the Force of  
any



any Objection from Dreams, &c. against the Certainty of Things existing without us.

§. 22. We have been the longer on this Sceptical part of Philosophy, that we might settle some certain Foundations of the Knowledge of Nature, and shew with what little Reason the two greatest Genius's which *France* has produc'd, *Descartes* and *Malebranch*, have endeavour'd to contest them, and on the whole we may make this general Reflection, That it is surprizing to think how easily we are led into the Disbelief of the most notorious and common Truths upon little Subtilties, and a few small Cavils and Pretences, which may possibly have the appearance, when we first view them, of invincible Objections, and yet when carefully examin'd often prove to be of no Importance in the Issue.

*Conclusion upon the trifling Pretences of these Sceptical Inquirers into Nature, and from thence of those who oppose Religion.*

Nor can we here omit to observe that of the same Kind and Complexion, with the present, are those Objections which are rais'd against our most Holy Religion; for which notwithstanding we have invincible Evidences, as plain and as certain as those for an *External Nature in Fact* existing; yet the mighty Puzzlers in *Reason*, would endeavour to convince us that we are not certain, tho' we may be assur'd of it; but if so manifest a Truth as that of *External Nature*, and *Matter of Fact*, is disputed by the best Genius's, and even upon Principles of *Reason*, it is no wonder that *Christianity* and *Matter of Fact* is so upon none by Men of a less elevated Understanding; since, if the Greatest and Wisest Philosophers are capable of such a Defect, in their Apprehensions and Judgments, concerning the plainest Matters, we need not be amaz'd at the Follies and Absurdities of others, in their Attempting to weaken the Evidences of Religion, who to their less Sense have taken care to employ a less Ingeniousness and Sincerity.

*Lock's Essay*  
Ch. 16. B. 4.  
§. 5, 6, 7, 8, 9, 10.  
Ch. 18. B. 4.  
§. 5, 6. Ch. 2.  
B. 4. Ch. 4. B. 4.  
§. 18.

## CHAP. IV.

*Concerning the Extent of External Nature,  
and the Opinions of Expansion, or a Va-  
cuum.*

*Next to the  
Reality we are  
to inquire into  
the Nature and  
Extent of Be-  
ing.*

§. 1. **I**T has been already prov'd, that we our selves exist, and that there is something likewise existing, which is external to us; from whence two Questions naturally arise, in respect of the latter, namely, What this External Being is, and how far it extends.

*Being is infinite,  
and to affirm  
that Nothing  
any where ex-  
ists is an ab-  
surdity.*

§. 2. To inquire how far External Being extends, is to ask, Whether there is any place in the Universe where Nothing exists, or Non-Entity: or, which is the same, Whether Non-Existence do's exist, an Inquiry which carries its own Confutation along with it. Nothing is only a Relative Term to Being, an abstracted Notion form'd in our own Minds, and which supposes and concludes that particular or general Entity, to which it is refer'd. Thus if we take Gold, for Instance, and compare it with any thing which is not Gold, that which has not the entire Essence of Gold, is nothing in that Comparison. So likewise in a Square, or a Triangle, which are suppos'd to be made up of an Infinite Number of Mathematical Lines, without any Breadth, if one of these Lines, which are presum'd to have no Breadth, is compar'd with the Square or Triangle, which has, it is esteem'd, as nothing in that respect and relation, which is infinite to it; in both which Cases it is no more than to say, the Gold, or Triangle, or Square, is it self, and cannot admit of any other Definition, or Denomination than what is given it.

And the same obtains in more general and abstracted Notions, than those of a Square, or a  
Triangle.

Triangle; as if instead of Gold we should substitute that of Being, and instead of a Square or Triangle, the still more comprehensive one of Quantity; Nothing, whether in respect of Being or Quantity, is not that Being or Quantity, and in other Words, is no more than to say, that Being or Quantity is what we mean by it, and not any thing else besides, 'tis a way or manner of considering Being; But to assert an Abstracted Notion exists without us, that is, that Nothing, which is a Creature of the Mind, do's, is an Absurdity.

§. 3. From hence it follows, that Quantity, as well as Being, is really Simple, and Undivided in itself; and when we speak of an Infinite Quantity, in respect of Nothing, or of a Square, in respect of its Side, it is the same as if we should affirm, *that Infinity and Nothing, different ways of considering the same Individual Being.*

Infinite Quantity, or *that* Square, possesses its own simple and Undivided Essence, and is no other than what it is, and that when it is exhausted to nothing, which belongs to it, it has its entire Nature; so that Infinity, and Nothing, are both of 'em only Modes of considering the same thing in different respects; on the other hand, this Simple and Undivided Essence may be *conceiv'd* to be divided into parts, which will be of the same Nature with the whole; thus Breadth, or a Surface, may be divided into a lesser Breadth, or Surface, and Length, or Line into a lesser; but a Surface cannot be divided into a Line without Breadth, or a Line into a point without Length.

§. 4. We would not here be understood, because *Tho' Infinity and Nothing are Relations of the Mind, and therefore only exist there, yet the Things related do exist.* we deny an Absolute Nothing, or Infinity to exist, that is, the Relations of Things made by the Mind dependent from the Things related, that we therefore affirm, there is not a Being or Quantity, which is Infinite in Comparison. God Almighty is Infinite in respect of his Creatures, a Superficies in respect of a Line, and a Line in respect of a Point, and this whole Universe, which we contend to be



infinite, in respect of the least Atome in it; and on the other hand, these are nothing in respect of the former: But what we defend is, that Nothing, as well as Infinity, is a Relation of the Mind, that it supposes Being, and do's not, nor cannot exist without it, and consequently the World or Nature is Infinite.

*The Creation of the World out of Nothing, explain'd.*

§. 5. Therefore when it is said, that God created all Things out of Nothing, no more is meant or intended, than that He made a World out of what it was not, and produc'd a Noble and Exquisite Order of Beings, which were not before; and this is suitable to the Description given us by the Great Law-giver of the Jews, of the Six Days Creation; that is, not that there was ever a time when Nothing existed, but that there was when this particular Frame and Disposition of Nature did not, since any other Notion of Nothing is Chimerical and Unintelligible.

For thus the Scriptures tell us, *That In the Beginning God created the Heavens and the Earth, and the Earth was without Form, and void, and Darkness was upon the face of the Deep, and the Spirit of God moved upon the face of the Waters;* which Account supposes something, tho' without Form, and all in Darkness and Confusion, that there was a Deep, and that there were Waters, even before the Creation.

*Next to the Extent of Being, what it is, is to be inquir'd; and first, what Universal Expansion or Vacuum is.*

Borelli.  
Sir Is. Newt.  
Princip.  
Mr. Raphson.  
Mr. Keil.

§. 6. Having therefore consider'd the Extent of Universal Nature, we are now to enquire secondly What it is, which is the Scope and Design of all Philosophy. And the next step from Nothing is Vacuum, concerning which Philosophers have not been a little perplex'd: However, the Present thinks they have solv'd the Difficulty, and that they have a Mathematick Demonstration that there is one; the Authority of the Arguments produc'd to prove it will make it necessary for us to search into their Validity, tho' we could heartily wish, that Reasoning



sonings of this kind might not be recommended to us, by the Greatness of the Names affix'd to them, but by the real truth we find in them.

§. 7. What is meant by a Vacuum is Space, exclusive of Solidity, &c. *i. e.* which is only extended into Length, Breadth, and Depth; The 1<sup>st</sup> Question is, Whether such a Being exists in Nature, which is affirm'd on both hands, and the 2<sup>d</sup>, Whether that which has such an Extension has not the whole Essence of Body? To both which we answer, That we cannot allow Extension an Existence, separate from every thing else, nor yet that it is the Essence of Body; and therefore, tho' we deny the *Vacuum* of the *Moderns*, we do not affirm the *Plenum* of *Descartes*.

*That there is neither a Vacuum in the Sense of the Moderns, nor a Plenum in that of Descartes.*

Sir Is. Newt:  
Princip. Defin. Schol.  
Descartes  
Princip. §. 4.  
Part. 2.

§. 8. Extension into Length, Breadth, and Thickness, or what is call'd mere Space or Distance, is a Quantity abstracted by the Mind, as all other Mathematical Quantities are, as a Line or a Superficies, and can be no more imagin'd to exist in Nature alone, than Length or Breadth can: A Line is produc'd from the Flowing of a Point, a Surface from the Flowing of a Line, and Space, or a Mathematical Solid, from the Flowing of a Surface, but 'tis own'd that there is no such real Point, and consequently no such Line in Being, therefore no such Surface, and what reason can there be assign'd why we may not go one step farther, and from the same Principles conclude, there is no such Solid; for how is it possible for a Superficies, which has not a Being, and is imaginary, and abstracted, to produce an Effect, which is not equally so?

*That a Vacuum do's not exist in the Sense of the Moderns, proved from the Notions of Mathematicians.*

§. 9. We have said, that Length, Breadth, and Thickness, is the Definition of Imaginary Space, and it is likewise the Notion we have of a Vacuum, as to the Nature and Essence of it; for the foregoing Properties of Light, or Heat, or Sound, &c. are not included in the Conceptions our Minds have form'd of Room to move in, or simple Space; if there-

*If a Vacuum exists, Imaginary and Real Space are the same.*

fore the Definition of Imaginary Space, and a Vacuum are the same, and a Vacuum, is Real Space, it follows that Real Space and Imaginary are the same, which is a Contradiction; since to abstract any thing in the Mind from Beings, as they really exist, is not to consider Beings as they really exist.

*If a Vacuum exists, there would be a Penetration of Dimensions, and therefore is only a Standard, or Measure fixt by the Mind of the Dimensions of Body.*

§. 10. The truth is, when we say any thing exists in Space, it is no other than to refer that thing which exists to a certain Standard we have lodg'd in our Minds of Space, which Standard we apply to that thing which do's exist; thus we measure Bodies by Material Feet, or Inches, which yet are distinct from those Corporeal Beings which are measur'd, and it is the same in our Measures from Space; for when we affirm a Body to exist in a Cubical Inch of Space, for Instance, the meaning of it is, that we have an abstracted Idea in our Mind of such a Capacity, which we apply to that Body which exists, tho' it no more in reality exists in that Space, than it do's in a Cubical Inch of Quick-silver, or of Water when immers'd into those Substances.

If this were not so, there would be a real Vacuum in the same place, where there is a real Plenum acknowledg'd, since a Vacuum consists of Length, Breadth, and Thickness, and so likewise do's a Body, or Plenum independent of Space, unless we will deny that Matter is in it self extended, and consequently there will be a Vacuum within a Plenum; or, which is as absurd, Space will exist in Space, or Extension in Extension, and there will be a Penetration of Dimensions.

*That it is such a Standard, prov'd from a Comparison betwixt the Density of Body and the Thinness of Space, and from*

§. 11. Besides this, that Space is only a standing Measure of the Dimensions of Body, delineated in the Mind, is evident; because if Body really existed in Space, that Space or Extension would be commensurate to Body or not; for Example, a Globe of Space to a Globe of Gold of an equal Diameter; if commensurate, it will be dis-

pers'd

pers'd through every part of the Gold, that is, *the Arithme-*  
 it will enter into each point of it, and by Conse- *rick of Inf-*  
 quence will be as thick and dense, which is con- *nites.*  
 trary to the Notion of Space or mere Extension,  
 if it is not commensurate to it, there will be some  
 parts of Gold, which do not exist in Space con-  
 trary to the Hypothesis.

We have affirm'd in this Section, that Space  
 would be as thick and dense as Gold, if commen-  
 surate with it; for an extended Substance, as that  
 of Gold and Space, consists of its extended  
 Parts or not, if not, there are Parts in Extension,  
 which are not extended; if it do's, the extended  
 Parts in both are equal, because the whole extend-  
 ed Substances are so; and consequently, there will  
 be as many extended Parts compress'd together  
 in the one Case as the other, but the thickness  
 or Constipation of Gold cannot proceed from any  
 thing else, than the close and compact Union of  
 its extended Parts, since thickness, or Constipation,  
 do's suppose nothing else in the Idea we have of  
 it, and if Space is commensurate to it, it must be  
 likewise as thick and dense, which is impossible.

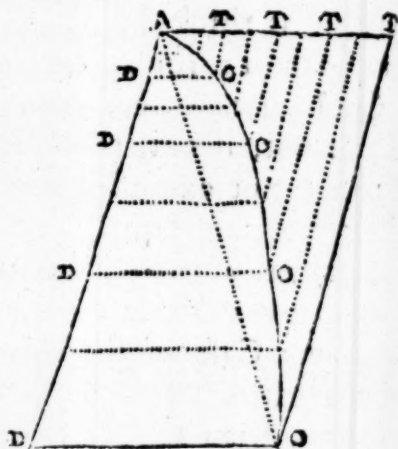
To explain this farther, according even to the  
 Sentiments of the present Philosophy, all Matter  
 is presum'd to be proportional to its Weight, but  
 all Matter is extended, and Space is so too, there-  
 fore in Gold, or in any other Matter, its Gravity  
 is proportional to its Extension, since the Exten-  
 sion of Matter begins and ends where Matter do's,  
 and attends it in all the intermediate Divisions of  
 it; consequently, if the Gravity of Gold or Mat-  
 ter is proportional to the Extension of Gold or  
 Matter, and the Gravity of Gold or Matter is in-  
 finitely greater than that of Space, the Extension  
 of Gold or Matter must be infinitely greater also,  
 and therefore, as before, impossible to be commen-  
 surate with simple Space; and for that Reason, ac-  
 cording to what was at first asserted, there will be

some parts of Gold, which do not exist in Space, contrary to the whole Tenour of a Vacuum, and of the present Philosophy.

Dr. Wallis  
Arithm. Infin.  
nit. Prop. 48,  
49, 50. and  
Prop. 60.

Besides these Philosophical Arguments, we shall produce some Mathematical ones to shew, that Space is only an Abstracted Idea, made and form'd by the Mind: Let  $AOTD$  be one certain and determin'd Space, or

Surface, which consists of Length and Breadth, if in this Space we can therefore prove, that several different Quantities may exist, each of which shall fill its Dimensions, we must either acknowledge that Space is an Abstracted Idea, form'd



by the Mind, to determine the Bounds or Capacity of Quantities only, without being the real Measure of them; or else, we must confess that different Quantities in the same Space, are the same; and that there is no Distinction betwixt the Proportions of 1 to 2, or 1 to 3, 4, 5, or whatever other Number we choose; which is an Absurdity, that do's not fall short of affirming that 1 is equal to 2 or any Number, which is different from it.

What we are consequently to evince is, that in  $AODT$ , there are several different Quantities included in the same individual Space, which is easily shewn, for if  $DAO$  is a Triangle, the Series by the Arithmetick of Infinites will be as 1, 2, 3, 4, &c. in the Ordinates, and since  $AD$  numbers those Ordinates, according to the Infinity of Points, which it is supposed to contain, those Ordinates will in there whole Series be to so many the



the greatest  $DO$ , as 1 to 2 by Prop. 44. of this Arithmetick; likewise, if  $AOOO$  represents a Parabola, by the same Prop. the Series of Ordinates, which are in a subduplicate Proportion of their Abscisses, and which are express'd by  $DO$ , and number'd by the same Line or Absciss  $AD$ , is to so many the greatest  $DO$ , as 2 to 3; if  $AO$  is the Curve of a Paraboloid, whose Ordinates are in a Subtriplicate or a Subquadruplicate Proportion, &c. of their Abscisses, those Ordinates number'd by the Points in  $AD$ , will be to so many the greatest  $DO$ ; as 3 to 4, 4 to 5, &c. on the contrary, if the Ordinates  $TO$  are suppos'd to be the Complement of the Semiparabola, since they are as the Squares of their Abscisses  $AT$ ; the whole Series of them will be to so many the greatest  $TO$ , and number'd by the Points in  $AT$ , as 1 to 3, if  $TO$ ,  $TO$  are not as the Squares, but as the Cubes, or the 4th or 5th Powers of the Abscisses  $AT$ , the whole Series of such Ordinates will be to so many the greatest  $TO$ , and number'd by the Points in  $AT$ , as 1 to 4, 5, &c.

And each Series of these Ordinates revolv'd upon the Axis  $AD$ , will constitute so many different Cones, consisting of an infinite Number of parallel Circles, which will be in a Duplicate Proportion of their Radius's; and consequently, an infinite Series of them to so many the greatest, or the Cylinder  $AOTD$ , in the Parabola and Paraboloids, as 2 to 4, 3 to 5, 4 to 6, 5 to 7, &c. and in the Complements of them, as 1 to 5, 7, 9, &c.

From this Doctrine it is evident, that  $DO$  the greatest Term in the several infinite Series, of the Triangle, Parabola, &c. is as  $AD$ , as the  $\sqrt{AD}$ ,  $\sqrt[3]{AD}$ ,  $\sqrt[4]{AD}$ ,  $\sqrt[5]{AD}$ , &c. and therefore the same Line admits of an infinite Number of Values, which multiply'd into  $AD$ , will likewise

produce as many distinct Surfaces *AOTD*, and those Surfaces revolv'd, an infinite Number of Cylindrical Spaces of different Values or Denominations; which yet are all included within the same Cylinder, or the same spatial Dimensions. Thus on the contrary, in the Complements of the Triangle, Parabola, &c. *TO* is as *AT*, as *AT*<sup>2</sup>, *AT*<sup>3</sup>, *AT*<sup>4</sup>, *AT*<sup>5</sup>, &c. and by consequence each of them Multiply'd into *AT* will produce Surfaces, and those revolv'd, Cylindrical Spaces, of different Values or Denominations, which, as before, are all comprehended betwixt the same Cylinder, or in the same Abstracted Idea of Space or Capacity.

It would not be difficult to add a multitude of other Arguments, from the Doctrine of Fluxions, and common Geometry, to shew, that in the same Space different Values or Quantities are consider'd; and consequently, that simple Space is nothing else than an Abstracted Idea, but we shall reserve what we have farther to alledge upon this Subject to our Principles of Philosophy, and our Treatise of Mathematicks, which we have begun, and shall moreover pursue, according as our other Studies, and our necessary Avocations will permit us.

*That it is also  
a Creature of  
the Mind,  
prov'd from  
other Ideas,  
being compre-  
hended in that  
of real Space,  
besides Length,  
Breadth, and  
Depth.*

§. 12. Farther, if there were any where about us an Existence, which was made up of Nothing but Length, Breadth, and Depth, there would likewise be an Existence which would only furnish us with those Ideas; for how Length, barely consider'd, should at the most produce any other Perception in us than that of Length, and so of Breadth and Thickness, it will be hard to say; but we do not find any Being in Nature, which gives us such Impressions or Sensations in General, distinguish'd and abstracted from all others, as Light, or Darkness, or Solidity, or some Quality or other, which is not comprehended in our Notion of Space, and consequently it must be an Abstraction and Creature of the Mind.

If it be alledg'd that those Qualities exist in Space, distinct from it, it is no more than to affirm that of one and the same individual Being, which we consider, Space and Extension is one property of it, and Solidity, or Light, or Darkness, or a Power of producing Sense or Feeling in us, is another.

We said in this Section that the *most* which Length, Breadth, and Depth could produce in our Minds, would be only those Perceptions, without a mixture of any other; but it is moreover evident, that Vacuum, or Room to move in, or which is the same, Capacity of Body, which consists of Length, Breadth, and Depth, could not raise in us *any* Sensations of themselves at all, no more than the Internal Space of Body can; they could exert themselves in no Action upon the Mind, and therefore could not in the least affect it; for when we see the Length and Breadth of whatever Portion of Matter we consider, it is by the Action of the Rays, reflected from them, but Length and Breadth have no Action peculiar to them, nor can they reflect any, and therefore could not give us any Information of their Existing; or, for it is the Case before us, an Abstraction made by the Mind cannot be seen by our External Organs of Sense, it is impossible that Colour should be seen, or sound heard, or any other Property of Body perceived, in the Abstract.

§. 13. However, that there is not a Vacuum in Nature will be more evident and clear, when we come to examine into the Affections of real Space, the mean time, if we were supply'd with no other Arguments, since the thinnest Substances, as those of Air, and the like, are Matter, and real Beings, than to give it a distinct Essence of its own, and to suppose it immaterial.

It is more reasonable to make real Space of the same Nature, with all other External Beings, than to give it a distinct Essence of its own, and to suppose it immaterial.

than

than to assign it an Essence distinct by it self, and different from every thing else in the World, and in consequence of it to suppose it Immaterial.

*The Reason of our Error in making Ab-  
stracted Space to exist, is, be-  
cause Extension is more con-  
stantly impress'd upon  
us, than any other Quality  
of External Being.*

§. 14. We shall add, that the Reason we are so forward in determining, that single Space or Extension exists, is, because it is impress'd upon us, from every thing we meet with, however other Properties of Beings vary, and by the several Senses of Sight and Feeling; It being therefore so constantly repeated on our Minds, and the other Sensations, which attend it, striking us uncertainly and faintly, we are apt to take Notice only of that which more strongly and uniformly affects us, and to drop those other Perceptions which belong to External Being, tho' equally a part of its Essence and Nature.

*That Space is distinct from Body in our Conceptions, no Argument that it is so in Existence.*

§. 15. And from hence it is, that those who defend a Vacuum lay such a mighty stress on the Distinction betwixt Body and Space; because, it being an Abstracted Idea, it must of necessity be different from the whole and compounded Nature, from which it is Abstracted; thus the Extension of Body is not the same with the Solidity, Colour, and Weight of it; and yet we wrongly infer from thence, that Space therefore exists distinct from Matter; since we may have an Abstracted Notion of Extension or Space, as well as of Solidity and Colour, tho' none of these should exist independent of each other.

*Lock's Essay, chap. 13. p. 84, 85, 86, &c.  
Edit. 3d. B. 1.*

*That Space has Properties, distinct from particular Bodies, no proof of its existing alone.*

§. 16. For the same Reason also the Arguments drawn from the Properties peculiar to Space, and which are not to be found in Matter, can be of no force to the proving of a Vacuum; thus, for Example, Space is said to be Incorporeal, because it is infinite, which Body is not, Indivisible, Immoveable, and which penetrates into every thing, Affections that are directly contrary to those we observe in Body, which is penetrable, divisible, moveable,



moveable, and finite; For how is Space Infinite, unless by the Mind's considering an intimate Extension, pervading all things abstractedly from the properties, which may possibly exist in it? Thus, supposing after a long tract of simple Space or Vacuity, we at length come to a Substance that is Solid, that is Heavy and Colour'd, and never mov'd out of the place it possesses, what is the Reason that the Being we call Space is not now interrupted and consequently defin'd, excepting that the Mind in its Abstractions rejects all other Qualities, and only considers that of Extension, in Exclusion of the rest? Upon the same account likewise it is that we affirm it to be indivisible, immovable, &c. which are all of 'em equally Marks and Descriptions of an Abstracted Idea, and depend upon the Supposition of an infinite, that is, of an intimate Space, form'd and determin'd in the Mind, by throwing out, and as it were pareing off all other Ideas, which are joyn'd with it, till we have modell'd and shap'd it into one undistinguish'd and invariable Perception.

And by a like method of Abstracting we might suppose Colour, (under which name I would rank Transparency, Light, Darknes, Opacity, &c. or the visible Qualities of Bodies) to be infinite, and to possess all the Properties which Space is confin'd to do, as also Weight and Levity, or, to comprehend both, the Moment of Being. But there is no due way of concluding, that therefore, either Space nor Colour, nor Moment exists in Body, because all these are immutable, and indivisible, and indivisible, consider'd abstractedly, and in General, whereas Body is not; since, when they are apply'd to particular Beings, without such Abstractions, they become determin'd and finite.

§. 17. It has been enquir'd, if all the Matter of the Universe was compress'd into two Spheres, whether or no there would not be a Space betwixt them,

Mr. Raphson  
De Spatio  
Reali, Cap. 5.  
P. 72, 73, 74.  
75, 76, 77, 78.  
79.  
Mr. Keil's In-  
trodunctio ad  
Veram Physi-  
cam, Lect. 2.  
p. 12, 13.  
Lock's Essay,  
chap. 13. p. 84.  
85, 86, &c.  
Edit. 3d. B. 1.

*The Argu-  
ments from  
the Spheres.*

or a Cylinder,  
no Evidence of  
a Vacuum.

Mr. Keil's In-  
troduct. Lect.  
2. P. 15.

Mr. Raphson  
De Spatio  
Reali, P. 63.

them, void of Matter, if we except the point of Contact; it is plain, from the Figures, there must be, and the same Conclusion will hold, if the two Spheres were resolv'd into one, seeing whatever is beyond the limits of such a Sphere would not be Matter; on the other hand, if all this Matter is not, or is not prov'd to be compress'd into two or one Sphere, the inference that can be made, is only of a Vacuum in Conception, and the possibility of apprehending such a thing as an Abstracted Notion of Extension or Space, which no one will deny, but it has not the least Appearance of a proof, that there is really such a Being in Nature.

And thus a Cylinder revolv'd about its own Axis, is no Argument, that Motion is perform'd in any other Space than what is Abstracted by the Mind.

*From the Idea  
of Space, or  
Vacuum, being  
only a measure  
fixt by the  
Mind, of the  
Dimensions of  
Body, it is easily  
deducible what  
Place is.*

§. 18. From this Idea of Space, being only an Abstracted one, it is easy to give an account of what Place is, namely, that it is only a portion of this Abstracted Space we have mention'd, separated from the rest, and by the Mind apply'd to that Body, which it considers as a Measure of its Capacity, but not of its real Extension, thus the real Extension of a Globe of Gold is different from its Place, which is determin'd by its Diameter, fixt in the Mind, and is the same upon that Account, whether it is computed by the Extension of Space or Matter, that is, by a Foot, or Measure made of Brass, for Example, or of Air, or of Vacuum; therefore Primary or absolute Place also, as well as Space, is a Creature of the Mind, and nothing really existing as some Philosophers imagine.

Sir Is. Newt.  
Defin. Schol.  
Lib. 1. Princip.

*From the same  
Doctrine it is  
plain, that Ex-  
tension is not*

§. 19. From hence it is likewise plain, that Extension is not the whole and entire Essence of Matter, since it is only one Property of it, which the Mind abstracts from its other Qualities, which,

we shall afterwards prove, are equally Essential to the whole Essence of Matter, and that we therefore do not defend the Presence of Matter. *Plenum of Descartes.*

§. 20. What still may farther confirm us in this Opinion, that Space is no other than an Abstracted Idea, is, that those, who assert a Vacuum, are oblig'd to make use of Negative Dimensions, lest they should be brought to acknowledge a Penetration of 'em; that is, they suppose so much Length, Breadth, and Thickness wanting in Space, as there is positive in Body, which is an evident Confession, that Body exists in nothing but its own Dimensions, and consequently, that Space is not distinct from Body, unless in Abstraction; for it is as impossible, that Negative Dimensions should positively exist, as that Nothing should, or that Nothing should be something, and for the same Reason, as in §. 2.

As for the Capacity of a Vessel, which still exists, whether full or empty, being the Vacuum, so much contended for, it is plain, that it is nothing else but an Abstracted Idea.

*The Negative Dimensions of Space affirm'd by Borelli, and the Capacity of a Vessel distinct from what is contain'd in it; asserted by Pythagoras, Democritus, and Epicurus, are a Confirmation that Space is only an Abstracted Idea.*

*Borelli de Motibus Naturalibus, &c. Cap. 12. Prop. 255. p. 330, Prop. 247. p. 320.*

## CHAP. V.

*The Arguments for a Vacuum consider'd, which are deriv'd from the Nature of Matter and Motion.*

1. **A**fter mentioning the chief Arguments for a Vacuum, drawn from the Distinction that lies betwixt our Ideas of Space and Matter; and having shewn, they are each of 'em many Confirmations of what we have advanc'd, it will be necessary to consider a second sort of Reason.

*That all the Arguments for a Vacuum, besides what have been consider'd, depend upon this that Ma-*

tion cannot be perform'd without one, and upon the Supposition of Matter being Similar and Homogeneous.

Reasonings, alledg'd in favour of the same Hypothesis, and which all terminate in this, that Simple Extension, or Space, is an infallible Consequence of Motion, as it is thought to be absolutely requisite to the being of it; what is produc'd from the Various Figures, into which any solid Body of Plenum shall be conceiv'd to be divided, and then put into Motion, or from a Vacuum in the Barometer, or from the Line which a Projectile describes, or from Pendulum's, or from specific Gravity, or from the Nature of Motion it self, all which we shall particularly examine into; it is no other in the result than a different stating of the same Question, Whether it is possible for Motion to be perform'd, without the Supposition of Space, or Simple Extension, and of a Similar and Homogeneous Matter.

The two Principal Arguments for a Vacuum, from the Nature of Motion.

§. 2. It is said Motion cannot be without upon two Accounts, First, Because, if we consider a Plenum consisting of an infinite Number of Parts, it is impossible for those Parts to move, without making Vacuity's and Interstices betwixt 'em. Second, Because of the Resistance there would be to Motion, upon the Hypothesis of Space being fill'd with Body; both which depend upon this Opinion, that Solidity or Density in Matter is every where the same, and Similar to it self.

The Argument for a Vacuum founded on the Motion of the Parts of Matter, one amongst another, consider'd.

Mr. Raphson De Spatio Reali, Cap. 4. P. 60. Borelli de Motibus Natur. &c. Cap. 12.

§. 3. As to the first, it is asserted, that the Parts of Matter must be of a Rectilinear, or Curvilinear, or a mixt Figure; that those which are Curvilinear and Convex, or Rectilinear and Convex, &c. cannot fill Space. On the other hand, that there are only the Angles of three Sorts of Regular Figures, viz. Six of an Equilateral Triangle, four of a Square, and three of an Hexagon that can fill Space, or in those that are Irregular as many as are equal to four right Angles, in plain Space, and in solid to eight, or to that which is comprehended by eight Cubes; that if there is more



more, there must be a Penetration of Dimensions, Prop. 262. &c.  
If less a Vacuum, and from hence it is concluded, P. 338, &c.  
that in the Motion of the several Parts of Matter,  
there must necessarily ensue a Vacuity betwixt

em.  
But this way of Arguing is built upon a Sup-  
position, that the World consists of one solid Mass,  
which, if it be imagin'd to be divided into a  
Million of what Parts we please, it is impossible  
they should move one amongst another, without  
producing an intermediate Space, and consequently a  
Vacuum; The Question therefore is, whether,  
if a Plenum is presum'd, it is necessary to affirm a  
Similar, or Homogeneous Matter, equally solid and  
inflexible, diffus'd thro' universal Space, or not;  
the present Arguments suppose it necessary to assert  
such a Matter; on the contrary, we expect a proof  
of so fundamental a Position, and till then shall  
take the liberty to refuse our Assent to it, as pre-  
carious and uncertain; for if a Similar, or Homoge-  
neous Matter was not suppos'd, and the Parts of  
it perfectly solid and inflexible, to what purpose  
would it be to contrive it into such certain and  
determin'd Figures, since they would not preserve  
their Shape the millionth part of a second of Time,  
after their first Motion, but in the Instant they  
chang'd their Position might, by their extreme  
flexibleness, alter their Figures into a Thousand  
different Ones?

This way of Arguing seems likewise to insi-  
nuate, that in the Motion of the Parts one amongst  
another, nothing External can possibly intervene  
betwixt the Parts, which are separated, excepting  
the Space which they leave; whereas, if, for in-  
stance, we should divide a Cubical Inch of Gold  
into ten hundred Parts, and give a force of moving  
to each of them, it would be impossible for them  
to move in their own Space, without taking in a  
Space External to them; and consequently, if  
that

that External Space is Material, they could not move in Vacuum, which is at present suppos'd, to extend only to the Dimensions of the Cube, for if it reaches farther, the Vacuum to be prov'd, by these Arguments, is in reallity taken for granted.

*The Arguments for a Vacuum, from the void in a Barometer, or Exhausted Receiver, consider'd.*

Rohault Par. 1.  
Cap. 12. Artic. 27.  
Abridgement of Mr. Boyle, Vol. 1. p. 306. &c. and p. 311.  
Rohault Par. 1.  
Cap. 12. Artic. 31.  
Mr. Boyle, P. 329. Vol. 1.

§. 4. The second is diversify'd into several Particulars, which yet all amount to the same Conclusion, and proceed upon the same Grounds and Principles.

The first sort of Arguments we shall consider under this second Head, is from the Barometer and Exhausted Receiver; in the former of which it is observable, that if there is any Air inclos'd betwixt the Quick-silver, and the end of the Tube, the descent of the Mercury is more gradual and slow; on the other hand, if all the Air is expell'd, there is no sensible Opposition to its fall, but it rushes down with a kind of Violence and Precipitation; agreeable to which in the Pneumatick Engine towards the last Exhaustions, the Sucker rises up to the Top of the Cylinder, and strikes forcibly against it, tho' before, whilst there was any considerable portion of Air included, it would not do it. In the Barometer likewise, if it is taken out of the Bason of Quick-silver, in which it is immers'd and plac'd upon the Finger, there will be no Pressure that can be perceiv'd from the Weight of the Mercury, but if the Air is permitted to enter at the Top of the Tube, it will immediately be felt as a load upon the Part, which lies under; suitable to this also, in the Receiver fill'd with Air, the Mercury of the Barometer stands at its usual Height, but in the Exhausted Subsides almost to a Level. That these Phenomenons, if made use of to prove a Vacuum, depend upon Matter and Solidity, being Similar and Homogeneous, is manifest, since, in all these Cases, the reason why a Vacuum can be affirm'd, is be-

cause

cause, if there were Matter or Solidity spread, through the whole Space of the Tube or Receiver, it would have the same Weight and Resistance which all other Matter has, that is, because all Matter is Homogeneous, and equally solid or resisting.

These Experiments also appear to conclude for a Vacuum another Way, namely, by supposing that whatever Air is exhausted from the Receiver, or expell'd from the Tube of the Barometer, it leaves nothing but a Simple and Immaterial Space behind it; whereas it is not certain, that what is expell'd or extracted is not of as gross a Nature, in respect of the Æther which is left, as Water is in respect of the Air, which is thus remov'd from the Barometer and Receiver, and that the remaining Æther upon the Motion of the Quick-silver to the Top of the Barometer, or of the Embolus, to that of the Cylinder of the Receiver, may not upon the infinite Momentum which presses against it, as easily strike into the Body of the Mercury, or the Embolus, as a Needle into the Parts of a Body, which it can penetrate with the least Resistance to it that is possible, or else, thro' the Cylinder or Tube it self, and in both Cases resume its place when deserted by that which invaded it; This yet we own impossible to be done, if Matter is the same, and is only subtiliz'd in its Parts, for then there must be a Vacuity; but that Matter is the same we deny: Moreover, in fact we see things thro' a Vacuum in the summit of the Barometer, and there are several Properties belonging to it, besides Extension into Length, Breadth, and Thickness, which could not be, if there was nothing there but Length, Breadth, and Thickness.

We must add, that altho' we have cited these Experiments as an Argument for a Vacuum, we do not do it in respect of the Authors referr'd to, the one directly asserting a Plenum, and the other

other expressly declining to enter into this Controversy P. 331. who, notwithstanding he had made all the Experiments necessary in the Exhausted Receiver to decide it, if it could be done by them, declares himself uncertain whether there was a Vacuum or not, all therefore that we produce these Experiments for, is only to obviate any Reasonings, which less Wise or less Knowing Persons might conclude from them, and it is upon the same Account that we mention several Objections against a Plenum from Sir *Is. Newton*, and others afterwards, which were never intended by them to demonstrate the Necessity of a Vacuum, albeit they have been perverted to that purpose, as we before prov'd in Chap. 1<sup>st</sup>, the Existence and Truth of our Faculties, because some Men of an inferior Penetration to *Cartes*, have carry'd his Method of Doubting much farther than even it was design'd by him.

This we say in the present Section, to vindicate our Philosophy from those sage Criticks we expect it will encounter, who may think to cavil with us for answering Arguments, which, when they find answer'd, they will perhaps say were not objected against us, for I am convinced by Experience and from a Conversation I have had with some Excellent Men in Philosophy and Mathematicks, that they now take several Propositions in Sir *Is. Newton* himself, as invincible Proofs of the certainty of a Vacuum, which were not design'd by that incomparable Geometer as such, and which therefore we are oblig'd to consider, not as Inference which he would make himself, but as those which others less Intelligent and Inquisitive would draw for him, and having said this, we hope we shall be excus'd upon any Citations of the like Nature which either have occur'd, or shall, in the present Philosophy.



§. 5. There is a farther Argument, which may be possibly drawn from the Barometer and Receiver, which differs from the last, namely, that upon repeated Exhaustions of the Air in the one, or upon the Expulsion of it from the other, the Space which is left, is either fill'd with Matter, or not; if not, there is a Vacuum, if it is, upon the least admission of the external Air, since the Space is the same, and the Bulk of Matter greater, there will be a Penetration of Dimensions: The Foundation of which Reasoning is grounded upon Simple Space or Extension, being real in Nature, which is only an Abstraction of the Mind, and has been already consider'd, and farther upon all Matter being the same; for if Space is only an Abstracted Idea, a Measure and Standard fixt by us to judge of the Capacity of any Being, and Matter is the same, Simple Space or Solid Body, may equally exist in that Idea, that is, Actual Space may first fill that Capacity and Body afterwards, without any Penetration of Dimensions; on the contrary, if Matter is not the same and Homogeneous, there can be no Reason assign'd why different sorts of Matter may not exist in the same Space, so as each of them should replenish the same abstracted Contents of it; but if Matter is indeed similar and invariable, it is altogether impossible that two different Portions or Quantities of it should, as it is that two Cubical Feet of Gold, for Example, should be circumscrib'd within the Dimensions of one.

*That if there was no Vacuum in an exhausted Receiver, a Penetration of Dimensions would necessarily follow, answer'd.*

This Argument therefore is also form'd upon the foregoing Principle, that Matter and Solidity are one certain and determin'd Thing, that they do not change into several shapes, but always preserve the same Individual and Identical Appearance. But all these Difficulties will presently vanish, when we come to shew the Real Nature of Matter, in our Principles of a True Philosophy.

*The Argument  
from Projectiles  
describing a Pa-  
rabolick Curve  
not conclusive  
of a Vacuum.*

Mr. Halley  
Miscel. Curios.  
Vol. 1. P. 315.  
Prop. 5.

Sir Is. Newt.  
Princip. Prop.  
10. lib. 2. Schol.

*The Argument  
for a Vacuum  
from the Revo-  
lution of the  
Heavenly Bo-  
dies examin'd.*

Dr. Gregor. A-  
stron. p. 282.  
Sir Is. Newt.  
Princ. Prop. 1.  
Lib. 1.

§. 6. As to the proving a Vacuum from the Parabola, which Projectiles are thought to describe, it is very evident that in the first place, that Demonstration proceeds upon the Hypothesis of Simple Space, or, which we have shewn to be the same, of its being an Abstracted Idea; since the Space describ'd by a Projectile, in its direct Motion, is presum'd to be as a series of Arithmetical Proportionals, when the times are so, and in its descending, as the Duplicate of them; the first of which is represented by the Ordinates of the Parabola, and the second by its Abscisses: But to suppose a Projectile describes equal Spaces, in equal Times, from the first beginning of its Motion, is to consider the Space it passes through as nothing more than mere Extension, form'd and delineated in the Mind; it is likewise evident in the second place, that if this Demonstration is, or can be justify'd by consequent Experiments, those Experiments would prove too much, namely, that the Air did not resist at all, since that is suppos'd in the Demonstration where a Parabola is described; for if we take another Supposition of a Medium uniformly resisting, there will a different Figure arise, which will approach nearer to an Hyperbola than a Parabola, and is therefore a Proof, that this kind of Reasoning is wholly Abstracted and Hypothetick.

§. 7. Of the same Nature with Projectiles is the Argument from the Revolution of the Heavenly Bodies, in an Immaterial or Void Space; for as their Motion consists of a direct and a gravitating, as before, so the Reasoning from it admits of the same Answer: For that Bodies revolving about an Immoveable Center describe Areas proportional to their Times, is, upon the Supposition of no other Force, but what is deriv'd from the Projectile, and Gravitating acting in conjunction; or, which is all one, this Arguing is upon the Hypothesis of Simple Space, or the Abstracted Idea of it: But a Demon-

stration



Ellipsis and Circle is the same, since, in the present Case, either Appearance is to guide us, or not; if it is, the Orbits of the Satellites are real Circles, and not Ellipses, according to the Theories of Astronomers, if not, their Appearing to describe Areas Proportional to their Times, will not be a Proof that they do, that is, they will either perform real Circles, and if they did not, would not describe Areas proportional to their Times, or else they will describe Areas proportional to their Times, and not revolve in Ellipses.

Besides which, granting the Ellipsis and Circle to be the same in appearance, for the same Reason that they cannot be distinguish'd at that immense Distance, which the Satellites are from us, if there were any Irregularities from the Resistance of the Medium, they would be still less discoverable than the Difference of their Apparent from their real Orbits, especially since in Projectiles near the Earth, and in the Quick-silver of the Barometer, and the Embolus of the Receiver, the small and insensible Resistance from the Æther, is not apparent to, or observable by us.

*The Uncertainty of arguing to the real Constitution of things, from the Coincidence of some Phenomenons with an Hypothesis.*

Dr. Gregor.  
Astronom. Lib.  
3. De Theoria  
Planetar. &  
Prop 1.  
Mercatoris A-  
stronom. lib 2.  
cap. 2.  
Gassendus Lib.  
2. Cap. 5, 6 & 7.

§. 9. It cannot be deny'd, but that according to the Prop. in §. 7, and upon the Hypothesis of Elliptical Orbits, pursuant to that Prop. in which the whole Area  $DEABCD$ , is to  $ALB$ , as the Time of the entire Revolution  $BAEDCB$  is to the Time of the Planets revolving in  $BA$ , the places of the Planets in the several parts of their Periods are much more exactly computed, than upon any other Hypothesis, and the Line  $AL$  falls in with that which is known, and determin'd by Observation: But it is likewise to be confess'd, that the Ancients, by their Hypothesis of Eccentricals, arriv'd at the same Conclusions, and defin'd with a sufficient Accuracy the place of any Planet, whose Orbit approach'd to a Circular, tho' where it departed too grossly from that Figure, as in *Mars*, they



they fail'd in their Calculations; as therefore that Doctrine, being an Abstracted one, was not answerable to Nature, so this, albeit it may come nearer the truth, cannot be justify'd from corresponding with only some certain Observations of Astronomers, since that did with several, and it is not evident that this do's with all; for altho' so far as just and rational Principles extend, as possibly the present of a Direct and a Gravitating Force are, so far right Inferences may be drawn, yet if they are too contracted and confin'd, if they are not of a Latitude adequate to the reality of Things, it is certain the Deductions from them must be defective in proportion, nothing being truer than that in a just Reasoning the Consequences cannot rise higher, or ly larger than the Premises.

§. 10. And this seems to be the Case of the present Astronomy, for notwithstanding it has happily got over the Difficulties, which remain'd to be solv'd in the Theory of *Mars*, it still labours under another Defect, in relation to the Errors and Irregularities of the Moon, the Solution of which has been carry'd as far as these Principles will admit, so as by Calculation to fix the true place of it in the several parts of its Orbit, and even in its Quadratures with the Sun, where the Difference is the greatest, within two Minutes, or Scruples, of what has been found by Observation; yet, notwithstanding this, there being something more in Nature, which was not consider'd, we may not unreasonably presume, that the Original Supposition of an Abstracted Space, is one Cause that that Celebrated Theory is not brought to its last Perfection, and therefore that not much more is to be expected in order to compleat it.

§. 11. Besides, it is plain, that Astronomers in their Calculations reject several *Minutia*, as they are call'd, which tho' they may not be significant to the main Design of Astronomy, the ascertaining

Kepler's Commentaries on Mars.

*The Theory of the Moon an Instance that the Hypothesis of an Abstracted Medium is defective.*

Dr. Gregor. Astronom. L. 4. Prop. 29. Schol.

*The Minutiae in Astronomy ought to have a place in real Nature, tho'*

not accounted  
for in an Hypo-  
thetick.

the Distances and Revolutions of the Planets, yet have their Weight and Importance, when we come to consider the real Constitution and Existence of Things; for the least Inaccuracy, tho' it be only, if it were possible, the Millionth part of a second, or third of a Degree, in their Reasonings, in Comparison with their Observations, allowing for the Defects of them, must have a Cause and Foundation in Nature, and will be most probably ascrib'd to the Particular Constitution of the *Medium*, in which the Planets move, and to the Distinct and Varying kinds of Matter, of which they consist.

Sir Is. Newt.  
Princip. Lib. 3.  
Hyp. 7.

Thus the Middle Distances of the Planets, and the Earth from the Sun, according to the Observations of *Kepler*, are of *Saturn*, as 951000, of *Jupiter*, as 519650, of *Mars*, as 152350, of the Earth, as 100000, of *Venus*, as 72400, of *Mercury*, as 38806, whereas, if computed by their Periodick Times, their Distances will be as 953806, 520116, 152399, 100000, 72333, and 38710. 'Tis true, there are other Observations of *Bullialdus*, which come nearer to the Calculations made according to the Periodick Times, but they likewise differ in some measure from them; and to suppose those Observations, which come the nearest to them, are the most exact, is to suppose those Reasonings true, which the Observations are brought to confirm; if the Difference notwithstanding was never so small and inconsiderable, there must be some Cause or other of it in Nature, which is not prov'd, *not* to be that which we assign, and which yet must be done, before any Arguments from the Revolution of the Heavenly Bodies can be of force against something in Space, besides Extension into Length, Breadth, and Depth.

Dr. Gregor.  
Astron. Prop.  
77. Lib. 1.

Omitting which, it is evident, that the Famous *Leibnitz* found out the very same Law of Gravitation, by which the Planets are retain'd in their Elliptical Orbits, namely, of its being reciprocally propor-

proportional to the Square of the Distance from the Focus, about which the Revolution is made, upon the Supposition of Vortices Harmonically circulating about the Sun, in which the Planets are carry'd, which Law, in the present Philosophy, is deriv'd from a quite contrary Hypothesis of a Void and Immoveable Space; so easy is it, for Men of Extensive Genius's, to solve the same Effect from different Principles, if rightly adjusted, to produce Phenomenons which agree; the Excussory Force, which is suppos'd in the Vortices, Harmonically Circulating, and by which the Planet would be mov'd in a Tangent, if not restrain'd by its Gravity, being answerable to the Projectile in the Hypothesis of Immoveable Spaces: We do not here inquire into the Objections alledg'd against such Vortices, it is sufficient that the Grand Principle of Gravity may be explain'd by them, as well as by a Vacuum, and if the accounting for it, and the Revolutions of the Planets, will not justify them from being false, the accounting for the same Principle, and the Revolutions of the Planets, cannot be a Demonstration that a Vacuum is true.

§. 12. Lastly, if there were no Sensible Force in Space, experienc'd by the Revolutions of the Heavenly Bodies, to conclude from thence against any sensible Material one, is, as before, to suppose that all Matter is the same, and its Forces or Powers so too; because there may be a Force in it, which is infinitely small, and therefore not observable, as was instanc'd in the Vacuum of the Barometer and Receiver.

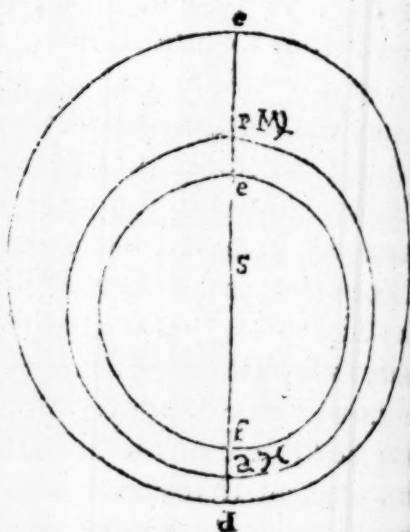
§. 13. And since we are now speaking of the Revolutions of the Heavenly Bodies, it will not be amiss to consider, Whether, altho' it should be proved, that the Planets are not carry'd in Corporeal Vortices, which a Plenum asserts, it is from thence necessary to affirm there is a Vacuum; certainly not, since, if Philosophers either give a wrong Explanation

*The Space should not have any sensible Force, a Vacuum from thence not prov'd.*

*The Confutation of Descartes's Vortices, no Argument against a Plenum.*

tion of a Plenum, or draw unjustifiable Consequences from it, there is no Reason to believe, or think the Hypothesis it self, upon that account, false.

Let *S* be the Centre of the Sun, round which three Orbits are drawn, of which the outermost *cd* is a Circle, whose Centre is in *S*, and of the two Interior ones *P* and *e* are the Periheliums, and *f* and *a* are the Apheliums, the Body therefore which is revolv'd in *cd* will proceed in a Uniform Motion, and describe Areas proportional to their Times, but that which is revolv'd in *Pa* will move slower in the Aphelium *a*, and faster in the Perihelium *P*, according to the Laws of Astronomy; whereas according to the Laws of Mechanics, the matter of the Vortex will move thro' narrower Space betwixt *f* and *d*, with a greater velocity, and thro' a larger, as betwixt *e* and *c*, with a less; that is, it will move faster in the Aphelium, and slower in the Perihelium, tho' before it mov'd slower in the Aphelium, and faster in the Perihelium, which is a Contradiction.



For Instance, if the Aphelium of *Mars* is in the Beginning of the Sign *Virgo*, since the Distance betwixt the Orbits of *Mars* and *Venus*, in the Beginning of that Sign, is to the Distance of the same Orbits, in the Beginning of the Sign *Pisces*, as 3 to 2, or thereabouts, the Matter of the Vortex betwixt those Orbits, in the Beginning of *Pisces*, will be swifter than in the Beginning of *Virgo*, in the Reason or Proportion of 3 to 2, according to the Mechanical Laws, that



the narrower the Space is, the swifter is the Motion of the same Matter thro' it, in the same Time of Revolution. Therefore if the Earth is carry'd about in this Matter, which passes betwixt the Orbits of *Mars* and *Venus*, and at the same Time isvolv'd about the Sun, its Velocity, in the Beginning of *Pisces*, according to the Mechanick Laws, would be to its Velocity, in the Beginning of *Virgo*, as 3 to 2, or in a sesquialterate Reason, that is, of one and a half; from whence it would follow, that the Apparent diurnal and Progressive Motion of the Sun, in the ecliptick, would be greater in the Beginning of *Virgo* than of 70 Minutes, and in the Beginning of *Pisces* less than 48; because the real Motion in the Vortex will be as 3 to 2, and when the Earth is in *Pisces*, the Sun appears to move in *Virgo*; and on the contrary, when the Earth is in *Virgo*, the apparent Motion of the Sun is in *Pisces*, i. e. the apparent Motion of the Sun would be greater in the Beginning of *Virgo* than of *Pisces*; whereas, by Observation, it is greater in the Beginning of *Pisces* than of *Virgo*, and consequently the Earth, in its Revolution about the Sun, is swifter in the Beginning of *Virgo*, than in the Beginning of *Pisces*, notwithstanding, by the Mechanical Laws, it was swifter in the Beginning of *Pisces* than in the Beginning of *Virgo*; or, which is the same, tho' the Earth moves swifter in the Perihelium *P* than in the Aphelium according to Astronomy; according to Mechanicks, it should move slower in the first, than in the last.

This seems to be a full Demonstration against *Cartesius's* Vortices, if the Mechanical Laws are true in the present Case, or if there can be no other account given of the Revolution of the Vortices, both which are far from being certain, or prov'd; for, supposing the Orbit of *Mars* is *cd*, and of *Venus* *ef*, it is resum'd from the Laws of Mechanicks, that the same Matter, in the same Time of Revolution, will

will move swifter thro'  $df$ , a narrower Space, and slower betwixt  $ec$ , which is a larger; which in the first place cannot be evidenc'd, unless  $cd$  and  $ef$  are solid Orbits, which will not yield to any Impressions of the Circulating Matter betwixt them; for whilst the Vortices of *Mars* and *Venus*, as well as of the Earth, are fluid, this Demonstration do's not evince, that when the fluid Vortex of the Earth from  $ce$ , is to pass thro'  $fd$ , (since the Force is increas'd by the narrowness of the Passage) it may not by that Force discharge it self into the contiguous Vortices of *Mars* and *Venus*, and from thence observe their Laws of revolving; for, as it lies betwixt them both, if the Vortex of the one is too swift, and should thereupon be capable of repelling the Matter of a foreign Vortex, there will be another ready, which is slower, to receive it; however this is, the Proportions of the Velocity of the Matter in the several Parts of the Vortices of *Mars*, the Earth, and of *Venus*, must be fixt and settled, so as to shew they cannot mix with one another, before such a Demonstration is Valid, which is not done.

Moreover, if  $cd$  and  $ef$  were solid Orbits, in order to make the Mechanick Laws prevail, it must be suppos'd, that the Matter of the same Vortex of the Earth increases its Motion betwixt  $f$  and  $d$  when there is no Force added to it, which is impossible; for the Matter of the Vortex of the Earth is either imagin'd to revolve in the same Time, or not; if it is, as in the present Argument it is thought to do, that is, as all the Matter passes betwixt  $e$  and  $c$ , so in the same Time the same Matter passes betwixt  $f$  and  $d$ , it is evident that the Force of the Matter which passes betwixt  $e$  and  $c$ , and which is certain and determin'd, is increas'd betwixt  $f$  and  $d$ , by a Supposition only of the Equality of Time, and revolving in that Time, without any new or real Force impress'd upon it.

it; but how a Supposition of the same Time should make the real Force of the Vortical Matter greater in  $f d$  than in  $e c$ , we are not yet inform'd; on the contrary, if the Vortical Matter revolves with a Force peculiar to it self, and unvary'd, where there is no external Force to alter it, which is more reasonable to think, the same Matter, with the same Motion, will be longer in passing betwixt  $f d$  than betwixt  $e c$ , which will not suit with this Demonstration.

Besides, the Supposition of the Matter's revolving in the same time, be the Spaces thro' which it is carry'd narrower or larger, is wholly Arbitrary; for we may as well presume the contrary, that the Vortical Matter is not revolv'd in the same Time, but is slower in its Motion thro'  $f d$ , as meeting there with more Resistance, and quicker in  $e c$ , where it meets with less, which will agree exactly with the Laws of Astronomy: On the other hand, if the Matter of the Vortex is not revolv'd in the same Time, this whole Objection vanishes.

Again, if the Mechanical Laws were acknowledged in the present Demonstration, if yet there may be other Laws of the Vortices revolving contriv'd, which shall answer the Astronomical, and has been attempted by *Leibnitz*, as we before observ'd, there will be no reason from any thing which is here offer'd to reject them.

Lastly, (for we do not defend the Vortices of *Descartes*, which we take to be Extravagant and Romantick) if this Objection against them was Valid, yet it do's not follow, that a Planet may not circulate in a Quiescent and Material Fluid in  $P$ , because it cannot be carry'd round in a Vortex, that is, in a Fluid, which is suppos'd to revolve with Conditions that are contrary to the Establish'd Rules of Astronomy, unless it is impossible for a Body to move in a Fluid that is entirely Material, and without any Vacuities, which resolves it self  
into

into the former Question, Whether all Matter is the same, and has a like Resistance.

*The Doctrine of the Descent of Bodies, and the Oscillations of Pendulums propos'd.*

Sir Is. Newt.  
Princip. Prop.  
24. Lib. 2.  
P. 303.

§. 14. Consonant to the Argument §. 6, 7, from Projectiles, and the Revolution of the Planets, is that from Pendulums, and the Descent of Bodies, according to the Series of Odd Numbers in an Arithmetical Progression, or as the Squares of the Times from the Beginning of their Fall, of which 1, 3, 5, 7, &c. are the respective Differences: As to what relates to Pendulums, the Proposition is, That the Quantities of Matter in Bodies which are Pendulous, whose Centres of Oscillation are equidistant from the Centre of Suspension, are in a Reason compounded of the Reason of their Weights, and a Duplicate Reason of their Times of Oscillation in Vacuum.

Which is thus prov'd; Because the Velocity, which a given Force in a given Matter, and in a Time given can generate, is computed by the Force multiply'd into the Time, and divided by the Quantity of Matter; for the greater any Force is, which is communicated, and the longer the Time in which a constant and successive Impression of such Force is made upon a Body, as in the present Case, the longer Gravity acts upon, and uniformly urges it, the greater must the Velocity be, and consequently must be made up by the Multiplication of one into the other; this Velocity will likewise be increas'd as the Matter is diminish'd, and therefore from dividing the former Product by the Quantity it contains, that is, the Velocity generated by a given Force in a given Matter, and in a Time given, will be as the Force, and the Time directly, and the Matter inversely; or if  $P$  is the Force,

$T$  the Time, and  $M$  the Matter as  $\frac{PT}{M}$ .

If now the Pendulums are suppos'd to be of the same Length, as in the present Proposition they are conceiv'd to be, the Motive Forces at equal Distances from the Perpendicular, or the lowest Point of



of the Arch, in which the Oscillation is made, will be as their Weights, as if one Pendulum is five times heavier than another, and both are held in a Horizontal Position, it will require five times more Force to sustain the one than the other, let them be afterwards sustained in an inclin'd Position, they will require a Force still less, till at length, when they come to the lowest Point of the Arch, there will be none requisite to sustain them at all; but the Motive Forces are answerable to the Sustaining, if the Bodies which are sustain'd are left to their own Motion; that these Forces also, at equal Distances from the Perpendicular, are proportional to their Weights, is evidenc'd from hence, because the Forces requir'd to sustain any two Pendulums, of equal Lengths, are as their Weights multiply'd into the Sines of their Archs, intercepted betwixt their places and the Perpendicular, and in the present Case, where the Positions are equally inclin'd, those Sines will be equal, and therefore the Motive Forces will be as their Weights alone.

Another thing necessary to the Demonstration of this Proposition, is, that if Bodies oscillate in equal Archs, and those Archs are suppos'd to be divided into several Parts, which are likewise equal, the Times in which the Bodies describe the Correspondent Parts of each Arch, should be proportional to the Times of their whole Oscillations, which is confirm'd, because the Velocity of the Pendulum falling from an Horizontal, or whatever other Position, in any Point of its Orbit, is equal to what it would acquire by falling thro' the Sine of that Arch, when impell'd by its uniform Gravity; and consequently, since the Velocities, where the Lines are strait, will be as the Motive Forces, and the Times directly, and the Quantities of Matter inversely; and since the Archs are under the same Conditions with strait Lines, it will follow, that in the Oscillations thro' the Archs and the

the several parts of them, the Velocities will be in that Proportion.

Let therefore  $U, v$  represent the Velocities of two equal Pendulums, at equal Distances from the Perpendicular,  $T, t$  the Times of Oscillation,  $M, m$  the Quantity of Matter in each,  $P, p$  their Weights, which in the present Circumstance will be as their Motive Forces, therefore  $U \cdot v :: \frac{PT}{M} \cdot \frac{pt}{m}$

$:: PTm \cdot ptM$ , And  $M \cdot m :: \frac{PT}{U} \cdot \frac{pt}{v}$ ,  $:: PTv$

$\cdot ptU$ ; for by the Inversion and Alternation of the first Proportion  $ptM \cdot v :: PTm \cdot U$ , or  $\frac{ptM}{v} = \frac{PTm}{U}$ ; But  $v \cdot U :: T \cdot t$ , and by Conse-

quence  $M \cdot m :: PT^2 \cdot pt^2$ , since,  $M \cdot m :: \frac{PT}{U} \cdot \frac{pt}{v}$

and  $v \cdot U :: T \cdot t$ , or  $\frac{T}{v} = \frac{t}{U}$  which multiply'd se-

parately into  $\frac{PT}{U} \cdot \frac{pt}{v}$ , makes  $M \cdot m :: PT^2 \cdot pt^2$ .

From whence it follows, 1<sup>st</sup>, if  $T=t$ ,  $M \cdot m :: P \cdot p$ ; 2<sup>d</sup>, if  $P=p$ ,  $M \cdot m :: T^2 \cdot t^2$ ; 3<sup>d</sup>, if  $M=m$ ,  $P \cdot p :: t^2 \cdot T^2$ ; because  $mPT^2 = Mpt^2$ , or  $PT^2 = pt^2$ ; 4<sup>th</sup>, since  $T^2 \cdot t^2 :: L \cdot l$ , the Lengths of the Pendulum which are now suppos'd to be different; if  $T=t$  and  $M=m$ , it will be  $P \cdot p :: L \cdot l$ ; for by the preceding  $\text{\AA}equations$ ,  $mP \cdot Mp :: t^2 \cdot T^2 :: T^2 \cdot t^2$ , if  $T=t$ , if  $M=m$ ,  $P \cdot p :: t^2 \cdot T^2$ , or  $:: T^2 \cdot t^2$ , i.e.  $:: L \cdot l$ ; 5<sup>th</sup>, Lastly in general, since  $M \cdot m :: PT^2 \cdot pt^2 :: PTv \cdot ptU$ , and the longer any Pendulum is, the less is the Velocity,  $M \cdot m :: \frac{PT^2 \cdot pt^2}{L \cdot l} :: PT^2 l \cdot pt^2 L$ .

Where the Lengths of the Pendulum are unequal, the following Demonstration was communicated to me, by Mr. *Saunderson* of Christ College, as thinking it more convincing than what

is before alledg'd,  $PT^2 \cdot pt^2 :: M \cdot m$ , and  $T^2 \cdot t^2 :: \frac{M}{P} \cdot \frac{m}{p}$ , on the Supposition of  $L = l$ , but if  $M = m$  and  $P = p$ , which is certain if  $T = t$ ,  $\frac{M}{P}$  is  $= \frac{m}{p}$ , let therefore  $L \cdot l$  be now unequal,  $T^2 \cdot t^2 :: L \cdot l$ , and if  $L \cdot l$ , and  $\frac{M}{P} \cdot \frac{m}{p}$  are unequal \*  $T^2 \cdot t^2 :: \frac{LM}{P} \cdot \frac{lm}{p}$ , and if  $T^2$  is  $= t^2$ ,  $\frac{LM}{P}$  will be  $= \frac{lm}{p}$ , moreover if  $M = m$ ,  $\frac{L}{P}$  will be  $= \frac{l}{p}$ , and consequently  $L \cdot l :: P \cdot p$ .

Likewise,  $PT^2 \cdot pt^2 :: M \cdot m$ , or  $P \cdot p :: \frac{M}{T^2} \cdot \frac{m}{t^2}$ , when  $L$  is  $= l$ , as before, if therefore  $M = m$ , and  $T = t$ , and consequently,  $\frac{M}{T^2} = \frac{m}{t^2}$ ,  $L$  and  $l$  being unequal, it will be  $P \cdot p :: L \cdot l$  by what is before demonstrated, let then  $L \cdot l$ , as also  $\frac{M}{T^2} \cdot \frac{m}{t^2}$  be unequal; and it will be \*  $P \cdot p :: \frac{LM}{T^2} \cdot \frac{lm}{t^2}$ , therefore  $PT^2 \cdot pt^2 :: LM \cdot lm$ , or  $\frac{PT^2}{L} \cdot \frac{pt^2}{l} :: M \cdot m$ .

But the same Objection lyes against this, as against the former, that the Proportions Markt with the Asterisk are true upon the Supposition of

$\frac{M}{P} = \frac{m}{p}$  in the first, or  $\frac{M}{T^2} = \frac{m}{t^2}$  in the last, for

if  $T^2 \cdot t^2 :: L \cdot l$ , or  $P \cdot p :: L \cdot l$ , it will be im-

possible that  $T^2 \cdot t^2 :: \frac{LM}{P} \cdot \frac{lm}{p}$ , or  $P \cdot p :: \frac{LM}{T^2}$

$\cdot \frac{lm}{t^2}$ , unless  $\frac{M}{P}$  is  $= \frac{m}{p}$ , and  $\frac{M}{T^2} = \frac{m}{t^2}$ , because, if

Quantities which are proportional are multiply'd by unequal Quantities, they will cease to be pro-

portional, but  $\frac{M}{P}$  is  $= \frac{m}{p}$ , and  $\frac{M}{T^2} = \frac{m}{t^2}$  on the Supposition of  $L$  being  $= l$ , whereas in these Proportions  $L$  and  $l$  are suppos'd to be unequal; we cannot therefore at present apprehend how these two Demonstrations are more forcible, than what is express'd before in shorter Terms.

Not being therefore satisfy'd, either with my own or my Friends Demonstration, where the Lengths of the Pendulum are unequal, I desir'd my Excellent Pupil, *George Newsome*, Batchelor of Arts, now Fellow of this College, and who, if it pleases Almighty God to spare his Life, will be one of the greatest Men in the Age, to consider the whole Proposition, the Demonstration of which I have here subjoyn'd, and which agrees with what we have before set down.

$$\begin{aligned} 1. \frac{V}{v} &= \frac{PTm}{ptM}, \text{ therefore } \frac{M}{m} = \frac{PTv}{ptV}, \text{ for } \frac{VM}{vm} = \frac{PT}{pt} \\ 2. \frac{v}{V} &= \frac{T}{t}, \text{ therefore } \frac{vT}{Vt} = \frac{T^2}{t^2}, \text{ and } \frac{M}{m} = \frac{PT^2}{pt^2}. \end{aligned}$$

From whence it follows, 1. If  $T=t$ ,  $\frac{M}{m} = \frac{P}{p}$ .

2. If  $P=p$ ,  $\frac{M}{m} = \frac{T^2}{t^2}$ . 3. If  $M=m$ ,  $\frac{P}{p} = \frac{T^2}{t^2}$ , for

$$\frac{M}{m} = \frac{PT^2}{pt^2}, \text{ and } \frac{Mp}{mP} = \frac{T^2}{t^2} \quad 4. \frac{L}{l} = \frac{T^2}{t^2}, \text{ and if}$$

$$T=t, \text{ and } M=m, \frac{P}{p} = \frac{L}{l}. \quad 5. \frac{M}{m} = \frac{PT^2 l}{pt^2 L} = \frac{P}{p}$$

*The Argument  
from Pendu-  
lums for the  
Proof of a  
Vacuum.*

Sir H. Newt.  
Princip. Prop.  
6. Lib. 3.

§. 15. From this Doctrine of Pendulums it may be inferr'd, that since it is founded upon considering Bodies, as moving in a Vacuum, and since likewise by the most accurate Experiments it is certain, that the Quantity of Matter in all Bodies is proportional to their Weight, which this Reasoning affirms, namely, Where the Times of Oscillation or Descent are Equal, which is also prov'd



prov'd by Experience,  $M \cdot m :: P \cdot p$ , it is consequent, that the Original Supposition of a Non-Resisting Medium, or a Vacuum, was right and agreeable to a true and exact Notion of Things.

§. 16. In answer to which we reply, that the Case of Descending Bodies and Pendulums is the same, but it is confess'd, that there is some check given to the Descent of Bodies in equal Times, from the Resistance of the Air, which Resistance must likewise obtain its Moment, in respect of Pendulums, tho' we should not perceive it, as it may not be always perhaps discernible, because of the shortness of the Tour a Pendulum takes, from whence it comes to pass, that it meets with little or no fresh Opposition, for whilst it repeats the same Footsteps, which it had mark'd out before, there seems to be no more force wanting to be subdu'd, than the Resistance made to its first Progress; the Fluid it moves in being afterwards agitated, and becoming pliant and obedient to its Motions, besides the great Disproportion betwixt the Weight of the Pendulous Body, and the Resistance of the Medium, will necessarily make the latter in a Manner imperceptible: That the first is true, appears evident from the Pendulums in Ships, for where their Place is continually alter'd, the Irregularities of their Oscillations are the greater, which cannot be wholly owing to the Motion of the Ship, but in some Measure must be to the Nature of the Medium, in which they Oscillate, since a difference is observable in different Climates, even where there is no Motion of the Ship to disturb them. Nor can we reasonably attribute it to an Alteration in the Figure of the Earth in various Parts of it, however ingenious some Calculations may be in order to prove it: that the last is true is also evident from the few Vibrations, which are perform'd by a light Body, in Comparison with those which are made in a Pendulum of an equal

*The preceding Argument, if true, would conclude against any Resistance in the Air, which is contradicted by Experience.*

Dr. Greg.  
Astron. Prop.  
52. Lib. 3.  
Sir Is. Newt.  
Princip. Prop.  
20. Lib. 3.

Length, by a heavier of the same Dimensions; be these Arguments as they will, for we have not time to enlarge on them now, this is manifest, that there is a Resistance in the Air, whereas this Abstracted reasoning supposes no such thing, and therefore, if it is a Proof of a Vacuum, it is also a Proof, that the Air do's not resist, contrary to Experience, and the confess'd Sense of Mankind.

*The Doctrine of Pendulums proceeds upon a wrong Supposition, and is equally mistaken in the Conclusions from it.*

§. 17. We may say farther, that this Reasoning is not just upon two Accounts, First, in presuming a Principle which is false, and second, by confirming the Conclusion from it by an Experiment, that is not true; for it is laid down as a Maxim, that by how much the force, or the time of Motion is greater, or the Matter less, by so much greater is the Velocity, which do's not universally hold, since the Reason of asserting the Velocity of any Body to be greater, as the Matter is less, is deriv'd from a fundamental Error, that all Matter is Passive in its own Nature, the contrary of which we shall Evidence in the ensuing Philosophy; and on the other hand, also shew, that the Experiments alledg'd are not valid, concerning the Quantity of Matter in that Sense in which it is receiv'd, being Proportional to its Weight, or Bodies Descending from the same Height in the same time.

*If there was no sensible Resistance in the Air, it will be no Proof of a Vacuum.*

§. 18. If all which notwithstanding was true, and there was no Resistance perceptible to the Vibrations of a Pendulum, to make this Argument effectual against a Plenum, that is to conclude there is no Matter where there is no sensible Resistance, is again, as before, to take it for granted, that Matter is Uniform and Homogeneous, and always resists in the same Proportion.

Thus far we have spoke in General, to what is propos'd to us in the present Doctrine of Pendulums, but since there is so much stress laid upon it

it in this Philosophy, we shall not refuse the Pains of examining into the several Parts of it. It is suppos'd, that Velocity is to be computed by

$\frac{PT}{M}$ , or by a Multiplication of the Time into the

Motive Force, and divided by the Matter, let us therefore 1<sup>st</sup>, Consider the Motive Force, in respect of Matter, and it is not evident that Velocity is increas'd, as the Quantity of Matter is less, excepting upon the Hypothesis of its being Similar and Homogeneous, for if there are any peculiar Forces in one Portion of Matter, which are not in another, a Computation of Velocity, which depends upon there being a certain and determin'd Nature in Matter, which only differs by its greater or lesser Bulk cannot be true: Thus no one ever, I believe, imagin'd that Fire, or Flame, or the Rays of the Sun, were reducible to the Laws of the Pendulum, or to this Computation of Impulses proportional to Matter, since it will be hard to find out an Impulse, which will affect the last; and it is manifest, there are some which extinguish the former, so uncertain is Matter, and so little compliant with an Imaginary Law of Flat and Uniform Impulses; and this is what we intended in §. 17.

2<sup>d</sup>. Let us next inquire into the Time, which the longer it is, the Velocity is said to be thereby also so much increas'd; that is, where there is a continual Succession of Impulses upon any Portion of Matter, the longer those Impulses are continu'd, the greater Velocity will be acquir'd to the Body impell'd; thus in Gravity, which is suppos'd to urge Matter with a Uniform Force, there is a constant Acquisition of Velocity to the Body, which gravitates by that Force continually acting upon it: But have we any Proof, or the least Shadow of one, that Gravity do's not act by one Impulse? This perhaps may seem strange to inquire, since it is reckon'd a constant Force must have a

constant Effect, 'tis true; But the Question is, Whether the Earth by Attraction, or the Body by Gravitation, is not resolv'd into one individual Force, which results from their own simple habitude, or respect to each other, in Relation to their own proper Faculties or Powers, which in certain Circumstances are certain and determin'd, and which therefore wou'd exert themselves in one Impulse, and at once; Thus, if two Bodies press upon each other, by those Forces which are given to them, whilst the Forces which press are constant, the Effects will be so too, but we cannot, upon this continued Force on both Hands, from thence infer, that there is any Acquisition in the Effect from the Continuance of the Cause; The Case is parallel in Gravity, in which tho' there is a continual Attraction of Body to the Earth in some Sense, yet it is not evident, that it may not be a Continuance of the same Cause, without any new and successive Impressions from that Cause. We do not however disown that Matter is accelerated the longer it continues falling; but to suppose, that Acceleration depends upon a continual Impulse from Gravity, by which the Velocity of the Descending Body is increas'd, is to suppose what we at present dispute; since, we shall afterwards endeavour to give a Solution of that Phænomenon upon other Principles; For if a continual Impulse of Gravity had a constant Effect, it ought to be as sensible to Bodies at rest, as those in a descending Motion, and it would not only accelerate Matter in its fall, but when in a State of Quiescence by a repeated Action upon it, must, at least in the Course of a few Years, produce some very remarkable Phænomenon, when in the Course of a few Minutes it is suppos'd capable of impressing so miraculous a Velocity; on the contrary, we do not experience any Phænomenon from thence, which is worthy of the least Notice, and a Body may



ly a hundred Years together, without acquiring one Degree of Force, more than it had at the Beginning, tho' it is constantly impell'd and batter'd with the Importunity and Insults of this Action.

Granting which, if again, as before, Matter is not Similar and Homogeneous, this part of the Supposition will likewise be invalid, for if there is Matter which do's not Gravitate at all, but seems to obtain a quite contrary Quality from Gravitation, this Doctrine of the continual Impulses from Gravity, will be of little Service to the explaining that part of Nature, which to all our Senses do's as much not Gravitate, as to all our Senses the other do's; and why the Gravitating part of Nature should be made a general Rule for explaining what we Experience do's not Gravitate, as in Fire and Vegetables, than why the Non-Gravitating part of Nature should be a Rule to the other, is not, nor cannot be shewn, unless, because there is more of Nature that falls under our immediate Observation, which do's Gravitate, therefore the rest must be submitted to the Laws it prescribes; Which is indeed a *powerful* Way of Arguing, because, there is a greater Number of Voices from Matter, if we may call it so, on the one side than there is on the other, but I am certain not a *Rational*, because, the one ought in a true Philosophy to be explain'd as well as the other; which upon these Principles they both of them cannot be.

34. In respect of Matter it self, it is suppos'd to be a resisting Substance, or not, if it is, where, or how is that Resistance explain'd? Not from the Principles of this Philosophy, (and we have no occasion to consider any other here, which we shall afterwards do) since a perfect Inertia of Matter is suppos'd in it; If there is no Resistance in Matter, how Velocity should be increas'd by Matters being diminish'd is inconceivable; for if we take a Globe of one or ten Inches Diameter, and the Mat-

ter has no Force belonging to it, but what we impart, or the Philosophers are pleas'd to bestow upon it, *that* Force will be the same, be the Magnitude greater or less, to which it is given; since the whole of an Abstracted Magnitude will resist no more than the least point of it, to the Force which is impress'd upon it; and therefore, both will be carry'd from such an Impression with an equal Velocity, and consequently, a Diminution of such an Abstracted Matter will be no increase to the Velocity.

4th. It is suppos'd, that the Velocities are Reciprocal to their Times, that is, that  $v \cdot V :: T \cdot t$ , but how that is agreeable to another Proportion affirm'd in this Philosophy, directly contrary to it, we are to examine; for by what has been said in §. 14.  $V \cdot v :: PTm \cdot ptM$ , upon all the Concessions which the present Philosophy requires; and therefore, if the Weight and Matter is equal  $V \cdot v :: T \cdot t$ , or which is the same, if one Point is acted by a continual Impulse, the longer the Action continues the greater will be the Velocity, on the other hand  $v \cdot V :: T \cdot t$ , or the longer the Time is, which the same Point takes up, in performing its Velocity, arising from one, and consequently from several Impulses, the slower such a Velocity is: If therefore,  $T$  and  $t$  in the first Case represents a Time, which accelerates Velocity, and in the second, a Time in which it is not accelerated but retarded, or which is the same, if  $T$  expresses the same Time, the Effects of which are different, that they can be us'd in this Demonstration promiscuously for one another, is not easily apprehended; for to suppose, according to the Proportion and Measure of  $T$ , that the Velocity is increas'd, and diminish'd at the same Time, is to suppose a Contradiction, and if  $T$  is not expressive of the same Time, the same Notation is us'd where different Things are meant by it.

To explain this farther, the present Case is concerning Gravity, which is thought to act by a continual and successive Impulse, and must necessarily from thence increase the Velocity; but the longer this Impulse acts, that the Velocity should be so much diminish'd in that time, is altogether incomprehensible; 'tis true, if Gravity was various in its Impulse, the Velocity produc'd from it would be reciprocal to the Time in which it was perform'd; but, since the Impulse of Gravity is uniformly the same, such a reciprocal Proportion cannot prevail, unless the suppos'd Force of a uniform Impulse from Gravity is destroy'd.

We shall therefore now consider the chief Corollaries, drawn from this Proposition, and as we have endeavour'd to shew the Principles upon which it is contriv'd are false, so the Deductions from it, when compar'd with what we find in Experience, we shall prove are so too: The first is, That if  $T, t$  are equal,  $M. m :: P. p$ , that is, if the Times of Oscillation are equal in the same Arch, the Matters will be proportional to their Weights; but Matter in its Descent, which is answerable, by what has been said before, to the Oscillations of a Pendulum, performs equal Times; and if a Globe of Gold, of Silver, Lead, Glass, Water, or Wood of the same Weight are set to Vibrate, they will likewise describe their Oscillations in the same Times, therefore the Quantity of Matter is proportional to its Weight.

The descent of Bodies we shall afterwards consider, and as to the Oscillations of different Sorts of Matter in the same Arch, and in the same Time, which are said to do it *diutissime*, we must ask, whether that means from the beginning of their Motion to their being quiescent, which I dare affirm it do's not, because it is contrary to all Experience; if therefore there are any Oscillations which are not perform'd in equal Times, why should not they as much contradict this Reasoning

Sir Is. Newt.  
Princip. Prop.  
6. Lib. 3.

soning as the others which are perform'd in equal Times, are suppos'd to confirm it, unless the first Oscillations are more to be regarded than the last, upon the Account of their Precedence; for if there is any outward Force, which causes this Difference in the Oscillations, we hope it will not yet be alledg'd in an Argument, which is the fundamental one to prove a Vacuum, and which supposes no Resistance.

Besides, let us allow these equal Times of Oscillation of a Globe of Gold, or Wood, this would be no Confirmation of the present Abstracted Reasoning, it would only prove, that different Matters of the same Weight did oscillate in equal Times, which is a Proposition some Degrees remov'd from this, that if the Times are equal, the Quantities of Matter are proportional to their Weights; for albeit the Globe of Gold, and of Wood, should oscillate in equal Times, excepting it is first shewn that their Gravity is proportional to their Matter; that is, that in the present Case the Matter in each Body is equal, as their Weights are, it will be of no advantage to the Proof of the present Abstracted Reasoning, and if it is shewn, it do's not want such a Reasoning to confirm it; the Truth therefore is, allowing the utmost to the Abstracted Reasoning, and to the Experiment, as they are both of them false, so if they were both of them true, they would signify Nothing to the Confirmation of the one, or the other, there being no Connection betwixt them. I know it is said, that as two Portions of Matter, if they are not of the same specifick Gravity, yet are equal in Weight, will perform equal Oscillations, so if they are of the same specifick Gravity and unequal in Weight, their Oscillations will be sensibly different; but what will this prove? *viz.* that equal Weights do oscillate in equal Times, and unequal Weights in unequal, which is far from proving that Matter is proportional to its Weight, or that equal



equal Portions of Matter have equal Weights, or unequal Portions unequal, because equal Weights oscillate in equal Times, and unequal Weights in unequal.

Lastly, This Corollary is nothing different from the Supposition necessary to the present Demonstration, for it is suppos'd, that if the Times are equal, the continual and successive Impulses will be computed by the number of Parts impell'd in each Body; that is, that the Matter in each will be proportional to the Impulses in each, but to suppose, is not the same as to demonstrate, and therefore we may justly reject such kind of Reasonings: We have not time to go thro' the rest of these Corollaries, nor is it requisite to do it, since they depend upon the same Principles which have been already confuted.

§. 19. What is possible to be produc'd from the descent of Bodies in favour of a Vacuum, is of the same Complexion and Genius with that which we have examin'd, in relation to Pendulums, and upon that account will not require a particular Answer here, having occasion to consider it under another Head; we shall therefore finish this Argument with an Experiment made, to prove there is no Resistance of any subtle pervading Matter to the internal Parts of Body, and which has been mistaken for an invincible Demonstration of a real Vacuum, because it overthrows the imaginary Plerum, which has been hitherto defended by Philosophers.

*The Descent of heavy Bodies consider'd under another Head.*

§. 20. Let a round Box of Firr, pendulous and empty, be set to Vibrate, and besides the first from whence it began its Motion, let three several other Places, which it reach'd after so many distinct Oscillations, be carefully mark'd, having before weigh'd the Air in the Box, the Box it self, the String that went about it, and half of it that was Pendulous, which always lies heavy upon the Body, and

*The Experiment of the Pendulous Boxes explain'd.*  
Sir Is. Newt.  
Princip. Prop.  
40. Lib. 2.  
Schol. p. 352.

and is to be computed into its Weight, the whole will be about the 78<sup>th</sup> part of the same Box, when fill'd with Lead, then shortening the String to the former Length, because of its being stretch'd by an additional Weight, and putting the full Box into Motion from the same place, there will be 77 returns before it falls into the second place, mark'd upon the Swinging of the empty Box, 77 more before it comes to the third place, and as many before it sinks to the fourth; but if their Resistances had been equal, the full Box would by its Native Force, being 78 Times greater than that of the Empty, have perform'd 78 returns; let now  $a$  represent the Resistance which is made to the external Superficies of the Box, and  $b$  that which is made to the inward Parts or Contents of it when Empty, the whole Resistance to the empty Box will be  $a + b$ , and to the full  $a + 78b$ , namely, the external Superficies added to the Density of the Matter multiply'd into the Capacity of it, which together will be the Measure of the Internal and External Parts, and consequently of the Resistance to both; but  $a + b : a + 78b :: 77 : 78$ , for if any Arch be divided into 78 parts, 77 of 'em, in the present Case, will be actually describ'd,

that is  $\frac{a+b}{a+78b} = \frac{77}{78}$  Parts, and by Division in

Proportion,  $a + b \cdot a + 78b - a - b = 77b :: 77 \cdot$

$78 - 77 = 1$ , or  $\frac{a+b}{77b} = \frac{77}{1}$ , that is  $\frac{a+b}{b} = \frac{77 \times 77}{1}$ ,

or  $a + b \cdot b :: 77 \times 77 \cdot 1$ , and by Division

$b \cdot a + b - b :: 1 \cdot 77 \times 77 - 1$ , or by Inversion

$a \cdot b :: 5928 \cdot 1$ , so that the Resistance of the Æ-

ther to the internal parts of the Box, is 5928

Times less than that which is experienc'd on the

outward Surface, which Resistance therefore must

be altogether insensible, if there is any at all, since

it is not improbable, but the Difference aforemen-

tion'd

tion'd may arise from the Velocity of the full Box, and the Length of the Space it delineates, which is much greater than that which is perform'd by the Empty one; for the more Space any Body passes through, the more Opposition it will meet with to its Motion.

§. 21. The foregoing Experiment, it is plain, is levell'd against a Plenum, which asserts a subtle Matter that penetrates into the Pores of all Bodies, by which their Motion might seem to be retarded, but there being no such sensible Effect, it is from thence argu'd to the absence of the Cause. If any farther use is made of it, namely, to evince in general the minute Resistance from the Æther to the Vibrations of a Pendulum, and from it the Necessity of several Vacuities interspers'd in its Substance, because otherwise it would resist as strongly as other Matter do's, we shall fall into the Question so often taken notice of, and repeated, Whether Matter and its Resistance is uniformly the same.

It is also to be observ'd, that this Philosophy in the foregoing Section confesses, that the more Space any Body passes thro', the more opposition it will meet with to its motion, which is an Acknowledgment of a continual Resistance in Space; and what we our selves are only farther desirous of, is, that such a Resistance may not be made by snatches and intervals, in proportion as it occurs with Particles of Matter here and there lodg'd in Space, which how it should be, we do not at present apprehend; but that it may be a Resistance diffus'd thro' all the parts of it, whatever it is, with some kind of uniformity; for if any one was to speak of a Resistance in Water, and should at the same time suppose the Parts of it were not contiguous, but irregularly dispos'd at several Distances from each other, he would be imagin'd to discourse upon Nature with some degree of being unintelligible and obscure, and why it should not be so in Æther, we

*This Experiment no Argument against a real Plenum, but against that of Descartes only.*

are

are not yet convinc'd, unless from the necessity which this Philosophy is under, of asserting the contrary, whilst it supposes all Matter to be Similar and Homogeneous.

*The Resistance of Bodies not much diminish'd from an Infinite Division of the Parts, is not much prov'd from a Cylindrical Vessel fill'd with Water.*

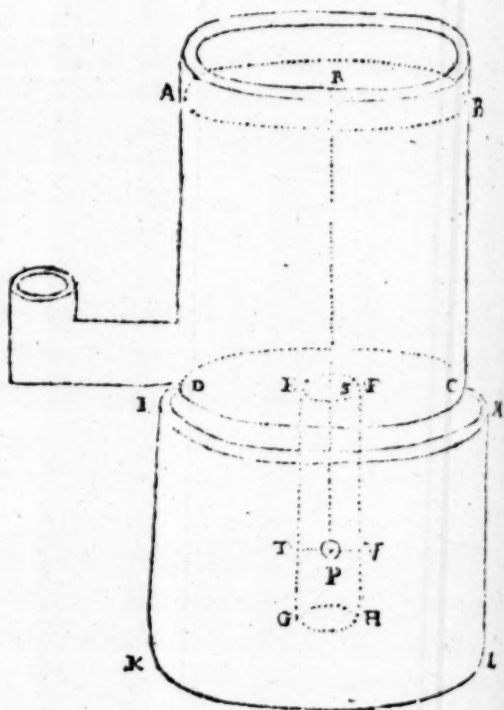
Sir Iſ. Newt.  
Princip. Prop.  
38. Lib. 2. P.  
332.

§. 22. The next sort of Arguments, to those from Pendulums, are drawn from the Nature of Motion,

and the Resistance to it, which is not much diminish'd by any Division of the Parts of

a Fluid, and therefore the subtile Matter of those who affirm a Plenū, will be of little Advantage to such an Hypothesis: This is prov'd from the present Figure, where *ABCD* ex-

presses a Cylindrical Vessel, incumbent upon another *IMKL*, both which are fill'd with Water, and a Passage made out of the uppermost into the lower, thro' the small Cylinder *EFGH*; they are likewise to be so contriv'd, that the bottom of the superior Cylinder may exactly correspond with the brim or margin of the other, that the Water may descend with a constant and uniform Motion, to which purpose there must be a void Space left, as *IM*, that the Water may have liberty to flow out, and make room for that which descends; and let the Globe *P* of the same specifick Gravity with Water be supported by a small Thread *TV*; if therefore we suppose a perfectly fluid Liquor at Water,





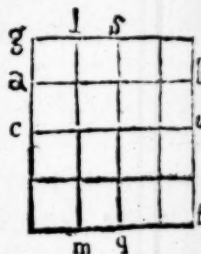
Water, the quantity of such a fluid, whose descent is hinder'd by the Globe *P*, will be to the quantity of the same fluid, which would have descended, had the Globe been taken away, as the Basis of a Cylinder circumscrib'd to the Globe *P*, to the orifice of the Cylinder *EFGH*, or as the Square of the Diameter of the Globe to the Square of the Diameter of the said Cylinder; farther, the Force which lies upon the Globe *P*, from the Water which presses upon it, is equal to the Column of Water *RS*, whose Basis is equal to the largest Circle of the Globe *P*, for the other part *SP* is perfectly stagnant, as is evident, if we conceive the Orifice *EF* to be stopp'd, and the pressure of the superior Column *RS* taken off, since in such a Case, as the Water would not flow out at the margin *IM*, every thing would remain in a state of quiescence; it is moreover manifest, that in what time the Water by uniformly descending in a Cylinder (the Diameter of whose Basis is equal to that of the Globe) describes  $\frac{2}{3}$  of the said Diameter, there will be enough to produce all the Motion of a quantity of Water, equal to the Dimensions of the Globe, because the Globe is equal to  $\frac{2}{3}$  of such a Cylinder, namely, whose height is the Diameter of the Globe, and the Basis equal to its widest Circumference; but it is the same, whether the Globe is quiescent, and the fluid moves with a uniform Velocity, or whether the fluid is quiescent, and the Globe moves with the same Velocity the contrary way; and therefore the Resistance of the fluid to the uniform progress of the Globe, in the time that it describes  $\frac{2}{3}$  of its Diameter, is the same as that Force which before produc'd Velocity in Water, whilst it describ'd the same portion of it.

From which Demonstration it appears, that where there is a perfect Fluid, as Water, the Resistance will not be much diminish'd, not even by an Infinite

nite Division of the Parts, since the Proportion before assign'd will nearly hold.

*That Resistance is so far from being diminish'd, in some degree, by the Division of the Parts of Matter, that it cannot be at all diminish'd upon the Supposition of a Plenum, in the Sense of Descartes.*

§. 23. To which we reply, That so far as this Argument affects those against whom it is design'd, viz. who affirm a Plenum, and yet find it necessary to introduce a subtiliz'd Matter, which in no respect differs from the most solid, unless in the minuteness of its parts into which it is divided, it proceeds in some measure rationally and justly, and comes near to a truth, which is evident in it self; for where we acknowledge all Matter to be the same, and to possess an equal Resistance the separating of its parts is inconsiderable, and can have no effect at all to the diminishing of it upon the Hypothesis of such a Plenum; for let us conceive a Square or Cube, as *g f*, to be divided into several Areolæ or little Cubes, if there is less Resistance than before, the Lines or Planes of Separation *lm*, *sq*, *ab*, *ce*, do not equally resist with the Areolæ or little Cubes, and therefore those Interstices are not Matter, which is suppos'd equally to resist; but to affirm there is no Matter, is to confess a Vacuum, and is contrary to the Supposition.



*The Argument from a Cylinder fill'd with Water, if apply'd to the proving a real Vacuum, or to the disproving a real Plenum in Nature, is guilty of several Absurdities.*

§. 24. If this Reasoning is intended as a proof against a real Plenum, and not the fictitious one we have mention'd, there is this Defect in it, that it endeavours to demonstrate the most solid Bodies cannot move in the most subtle Fluids, without a very sensible Resistance from a Globe moving in the Water, which has the same specifick Gravity with it, which is to suppose all Matter abstracting from its Pores, and its particular Forms is the same, since the most solid Bodies, and the most subtle Fluids, are determin'd as to their Properties and Relations, from those of the like Matter and Gravity; and hence is deriv'd that Notion, which would

would otherwise be inconceivable of \* a most subtle \* Sir If. Newt.  
Fluid, which has the same Density as a Solid; name- Princip. Prop.  
ly, it is apprehended, that nothing goes to the 38. Lib. 2.  
making of a Fluid, except the Lubricousness of Corol. 1.  
the parts, and nothing to the Subtlety of such a  
Fluid, but the fineness and minuteness of 'em;  
but that in other respects the Matter of both So-  
lid and Fluid is similar and invariable.

Farther, if this were not affirm'd, but the con-  
trary own'd, that there might possibly be Matter  
infinitely different in its Gravity and Resistance;  
this Demonstration, if it is Valid, at the same time  
acknowledges, that a Fluid, whose Gravity is in-  
finitely small, presses upon the Globe *P*, which is  
of an infinitely greater, with an equal Force of Gra-  
vitation. 2d, That Motion, which proceeds from  
Gravity, in the present Case, may be produc'd  
from that which do's not sensibly gravitate, as we  
suppose *Æther* do's not. 3d, That Action and Re-  
action betwixt a Force and no Force, in compa-  
rison with it, that is, betwixt a solid Body and  
*Æther*, is equal: Lastly, that Body and *Æther* is  
of the same Specifick Gravity, all which must be  
affirm'd, if *Æther* is taken instead of Water, and a  
heavy Body instead of the Globe *P*; But since these  
are palpable Contradictions, or plain Absurdities,  
it is evident, that no such thing is suppos'd as a Dif-  
ference in the Gravity and Resistance of Matter,  
consider'd in its own Nature, and therefore, that  
the contrary is presum'd as an infallible Prin-  
ciple.

We shall not here observe, That granting this, Sir If. Newt.  
and the Notion of a *Fluidissimum*, which is said to Princip. Prop.  
consist in the utmost Lubricousness of parts, Wa- 40. Lib. 2. &  
ter is not prov'd to be such a Fluid, and that it Schol. p. 350.  
may not be as viscous, in respect of *Æther*, as any  
other gross and intractable Fluid is, in respect of  
it; and yet on this, in a great measure, the Stress  
of the present Demonstration lies; for if it is Vif-

cous, compar'd with  $\text{\AA}$ ther,  $\text{\AA}$ ther or Material Space will resist in a much, and perhaps an infinitely less Proportion to it, than is here defin'd.

*That a Fluid, infinitely subtiliz'd, will resist as much to the Motion of Bodies, as one whose Parts have not undergone the same Diminution.*

Sir Is. Newt.  
Princip. Prop.  
40. Lib. 2.  
& Corol. 1.

§. 25. Of the same Class with the former is the Proportion alledg'd by this Philosophy, and is founded upon the same Reasoning: The utmost Resistance to a Solid given, in a given Fluid, is first to be determin'd, and the Solid afterward to be encreas'd to an Infinite Magnitude; it will then be as the Motion that is lost from Resistance, whilst an Infinite Solid describes the Length of its Semidiameter in a Definite and Certain Fluid, to the Motion it had at the Beginning; so the Motion, which is lost from Resistance, whilst a Finite Solid describes the Length of its Semidiameter in an Infinitely subtle Fluid, to the Motion it had at the beginning; because a Fluid, not subtiliz'd, has the same respect to a Solid Infinitely increas'd, which a Fluid Infinitely subtiliz'd has to a Solid which is Finite, and not encreas'd, all other things being equal; let us therefore now suppose, that upon the Augmentation of a Spherical Solid, the Resistance made to it, in a Fluid, is likewise augmented in a Duplicate Reason, that is, in Proportion to the Cylindrical Space, thro' which it is mov'd, which is as the Circular Base of the Cylinder, or as the Square of its Diameter; if so, the Resistance of a Spherical Solid will not be any ways diminish'd, from an Infinite Diminution of the Parts of the Fluid, seeing, in both Cases, a Resistance is made in a Duplicate Proportion of the Diameter, and therefore will be the same in Effect, whatever Diameter we take.

*The Preceding Section an Argument against the Fictitious Plenum of the Moderns, but not against a Real one.*

§. 26. That this Demonstration is grounded upon an Identity, or Sameness of Matter, in its own Nature, and upon there being no difference betwixt one Portion of it and another, unless in the Magnitude of its Parts, is very manifest; for if we imagine the encreasing a Solid or subtilizing a Fluid, in



in another sense than what concerns the making their Parts, or their whole Mass greater or less, the Proportion will either be wrongly stated, or foreign to the intention of introducing it, that is, if the Solid is encreas'd in respect of its Bulk, and the Fluid subtiliz'd in respect of its Density, and the Encrease and Diminution is not consider'd with relation to the same Property of Matter, either of Magnitude or Density, the Proportion will not obtain; if the Solid is increas'd, and the Fluid subtiliz'd, in respect of its Density, to which Resistance is proportional, it would prove no more than that an Infinite Resistance would be to a Finite one, as a Finite Resistance to an infinitely small one, which would signify nothing to the Confutation of the Subtle Matter against which these Arguments seem to aim.

To conclude this Section, we cannot omit to take notice of the Uncertainty of this sort of Demonstrating, since here it is inferr'd, that an Indefinite Division of the Parts of Matter cannot make the least Diminution of Resistance; whereas, from what was prov'd before §. 22, upon the Supposition of such a Division, it was inferr'd, the Diminution was not much; but to say, there is a very small Diminution of Resistance upon an Infinite Division of the Parts of Matter, and to say there is none, are two different Assertions. Besides what we have said, that which is more, is, that some Fluids do in Fact resist much less than others as Spirituous than Viscid ones, which, for all that this Philosophy can demonstrate to the contrary, may proceed from a Difference of Figure or Magnitude in the Parts, or rather must do it, since it considers nothing else in Matter than Figure, Magnitude and Solidity, or a Matter in general, which is Homogeneous.

Sir Is. Newt.  
Princip. P 390.

§. 27. Lastly, it is said, That if we should take a Globe of any solid Matter, as Gold, and con-

*Because Gold cannot move in its own Sub-*

ceive

*stance without  
a Vacuity, no  
Reason why it  
may not in an-  
other Substance  
equally Mate-  
rial.*

Lock's Essay,  
Chap. 13. B. 2.  
§. 22.

ceive the smallest part that can be imagin'd to move in it, such a Motion would be impossible without a Vacuity; which if it is, an Argument against a Plenum, it is upon this Supposition, that all Matter is equally dense, and therefore the Motion of any Body in the most Fluid Substance, so far as that Substance is Matter, lies under the same Circumstances, as Gold moving in its own: Suitable to this is that Irrefragable Proof, as it is esteem'd, of a Vacuum from an apparent Difference in Specifick Gravity, and which has been hitherto thought to rise to a Demonstration; we shall therefore upon that account more particularly consider the Force of it, tho' we cannot but think it depends upon the same Foundation with the former, since Gravitation is no other than a certain kind of Motion, which could not be produc'd upon the Hypothesis of a Plenum, if all Matter in its own Nature and Essence was equally constipated and condens'd: As to what respects a Particle of Matter being incapable of moving in its own Dimensions, see §. 3.

*The Demon-  
stration of a  
Vacuum, from  
the Difference  
observable in  
the Specifick  
Gravities of  
Bodies, ex-  
plain'd.*

Sir Iſ. Newt.  
Princip. Prop.  
6. Lib. 3. with  
the Corollarys.

§. 28. The Principle from which the Necessity and Certainty of a Vacuum is affirm'd, is, that all Bodies Gravitate to their several Planets, and in equal Distances from the Center of them, in proportion to the Quantity of Matter each Body contains; for that Bodies descend to the Earth, in equal times from the same Height, has been observ'd by *Galileo* and others; and in Pendulums, it is said, we may plainly discern the truth of that Assertion; since, if we take of two different Matters, *viz.* Gold and Wood, a like weight, and let them vibrate from the same Center of Suspension, and in the same Center of Oscillation, that is, let the Radius of their Motion drawn from the fix'd Center to the Center of the Body, which vibrates and describes the Circumference, be equal, the two Bodies will make their Progress and Regress together for a considerable time, and there will not be any sensible Difference in the Returns of

of the Pendulums; whereas if two Bodies of the same Specifick Gravity, tho' one has only  $\frac{1}{1000}$  part of Matter more than the other, are set to vibrate, there will be a manifest Distinction in their Oscillations: But by Sect. 14. if  $T=t$ ,  $M.m :: P.p$  that is, if the Times of Oscillation or Descent, are equal, the Matter is proportional to the Weight, and therefore all Bodies gravitate according to the Matter contain'd in them; and since the Weights, in the present Case, are suppos'd to be equal, the Matter in both is so likewise.

To make this Affection of Bodies universally obtain, it is extended to the *Moon*, to the Satellites of *Jupiter*, and the Circumsolar Planets, in respect of their several Centers, about which they revolve, for since by other Arguments it is evinc'd, that their Accelerating Gravities, that is, the Velocities, which they have in their Tendency to their particular Centers, are reciprocally as the Squares of their Distances from them, it necessarily follows, that in equal Distances these Accelerating Forces, or those Velocities, will be equal; but where Bodies of an unequal magnitude are driven with the same Acceleration to their Center, and the Acceleration of the whole consists of that of each part, the whole Force of the one will be to the whole Force of the other, in proportion to the Bulk, that is, their Weights will be as the Quantities of Matter they contain.

If the same Property also did not prevail in the Satellites of *Jupiter*, and those of *Saturn*, in respect of their Gravitation to the *Sun*, as well as in those Planets about which they are carry'd, their Orbits would be irregular and perplex'd, from the Inequality of Attraction; for if in equal Distances from the *Sun* the Accelerating Gravity, for Example, of any one of the Satellites of *Jupiter*, was more or less than the Accelerating Gravity of *Jupiter* himself by  $\frac{1}{1000}$  part only of the whole, and there-

fore was more or less heavy in proportion to its Matter than *Jupiter* in proportion to his, the Distance of the Center of its Orbit from the *Sun*, by a just Computation, would be greater or less than the Distance of *Jupiter*, its real Center, by  $\frac{1}{2000}$  part of the whole Distance, or, which is the same, by a fifth part of the Distance of the outmost Satelles from the Center of *Jupiter*: But such a Difference would visibly make the Satellites move in Orbits Eccentric to the Planet, whereas by the Universal Acknowledgments, and Determinations of Astronomers, they are Concentrick to it.

Lastly, if the several Parts of every Planet, or Satelles, did not gravitate proportionally to their Matter, the whole would not; it has been prov'd, the whole do's, and therefore it is Consequent, that the several parts of it must; since otherwise those parts which gravitated more or less, than in proportion to the Quantity of Matter they possess'd, according to their prevalence, would make the Whole gravitate more or less than in that Proportion.

From which establish'd Principle of Corporeal Beings it is concluded, that the Weight of Bodies is not to be estimated from the Figure or Texture, or the particular Composition of the whole, or its Parts, but from the intrinsic Matter they contain; for if we take equal Portions of Matter, and change them into as many Shapes and Forms as we are capable of inducing upon them, their Weights will continue unalterably the same; and since *Æther* do's not differ from other Bodies, unless in the Form and Composition which is proper to it, it must likewise gravitate in the same Proportion, that is according to the Quantity of Matter it is charg'd with; and from hence is infer'd the evident Necessity of a Vacuum: Because if there was a real Plenum in Nature, it would gra-  
vitate



vitae in Proportion to the Matter it contain'd, that is, there would be every where an equal Force of Gravitation, and consequently Gold or Quick-silver, for Example, would not descend in Space, for the same reason, that other Bodies do not, excepting in Fluids specifically lighter than themselves; but in a Plenum all Bodies are equally heavy, and have an equal Force of Gravitation, and therefore, there can be no such thing as specifick Gravity contrary to common Sense and Experience.

§.29. There are two Particulars therefore to be ascertain'd in this Argument, First, That all Matter gravitates in Proportion to its Quantity, Second, That all Matter which gravitates in Proportion to its Quantity, is the same, or Similar and Homogeneous; there are some offers at a Demonstration of the former, whereas the last, tho' equally necessary to be prov'd, is not in the least consider'd; That Matter gravitates in Proportion to its Quantity, is made general by an Induction of the several Cases incident in Nature, as of Pendulums, and descending Bodies, of the Planets, of the Satellites of those Planets, and lastly of the constituent parts of them.

§.30. As to the descent of Bodies, being made in equal Times from the same height, there is no Experiment which can convince us of its Truth, so as from thence to prove, that the Gravitation of Matter is proportional to the Quantity of it; for tho' by Observation, or by the Calculation from the Pendulum, Bodies should universally describe in their fall 15 Paris Feet and  $\frac{1}{2}$  in a Second of Time, or the 60th part of a Minute, without any Distinction that can be discern'd, it do's not follow that there is no real difference in their intrinsic Moments or Force, besides what proceeds from the Quantity of Matter they receive or comprehend; since it is confess'd, that Bodies have a mutual Attraction to each other, which

*In the Demonstration alledg'd two things are to be prov'd, that Matter gravitates in proportion to its Quantity, and that that which do's so is Similar and Homogeneous.*

*Nothing certain from Pendulums, or the Descent of heavy Bodies, that Matter gravitates in Proportion to its Quantity.*

internal Property and Inclination is yet stiff'd, and oppress'd by the infinitely greater Attraction of the Earth; so that, as the only way to discover, whether two Bodies gravitate to one another, is to set 'em at an infinite distance from all Matter whatsoever, whereby they may be resign'd to their own Actions; so, if we would try whether the Weight of Matter is not apparently but really proportional to its Quantity, such an Enquiry is not to be made by Experiments taken near the Earth, or within the Sphere of its Attraction; because, tho' Matter had some innate and peculiar Force of its own, it would be oblig'd to obey the stronger Impressions it receives, from that vast and immense Heap of Bodies, which acting uniformly upon all that Surrounds it, it is likely, would in equal Distances produce much the same Effect.

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And for this Reason the Moon likewise is submitted to the same Laws of Gravitation, which, as appears by Calculation from its Periodical Motion, if it were to descend from its Orbit to the Earth, would describe 15 Paris Feet and  $\frac{1}{12}$ , in a Minute, upon its first setting out; for the Distance of the Moon from us is 60 Semidiameters of the Earth, and Gravity is encreas'd, as the Squares of the Distances are diminish'd, and consequently, the same Force, in its approach to the Earth, will be as  $60 \times 60 \times 15 \frac{1}{12}$ , or will descend 15 Feet and  $\frac{1}{12}$ , in the 60th part of a Minute, which is the very Affection or Property of what we call Gravity here.

But this is no Proof that heavy Bodies would not have different Forces of Gravitation, if they were left to Act according to their own proper Moments and Pondus, even altho' the Quantities of Matter were the same; for if all Matter did gravitate alike in Appearance, it would not be an Argument that it did so in Reality, and which we mention here, not so much to shew the weak-  
ness

ness of what is alledg'd in favour of a Vacuum, (for if all Matter gravitated *apparently* alike, it would be sufficient in the present Case) as to prevent any prejudice, which may arise from so general an Affirmation, and which may be of use hereafter.

§. 31. To proceed therefore; as to what respects a Vacuum, it is plain, that the Reason why all Bodies are said to be in Proportion to their Weights, is upon the Presumption, that all Matter is the same; for, since the Descent of Bodies or the Accelerating Forces being equal, the whole moment of 'em must be computed from the several Parts which are accelerated, if those parts of Matter are uncertain and various, if they are different in their real Being and Extension, if they are not the like individual, solid, extended Parts, they cannot be a standing Measure of the whole Moment and Weight of equal Forces impress'd upon them; for, let us suppose two Spherical Bodies of equal Diameters to have the same Acceleration to the Center, their Weight will be as their Bulk is, equal, upon the Supposition, that the Matter in both is the same.

But, if the Contents of the one are not equal to those of the other, tho' they have the same spatial Dimensions, their Pondus, or their entire Compound Gravitation will not be equal; because, the same accelerating Force is communicated to different Subjects, which is the very Foundation of affirming, that Bodies, where their Matter and Acceleration are the same, and their Bulks different, are proportional to their Weights, and therefore will be as well a Proof, if Matter is not Uniform and Homogeneous, that it is not proportional to its Weight, as if it is Uniform and Homogeneous, that it is; so in a Globe of Gold, and an equal one of Water, the Reason wherefore the Quantity of Matter in both is Estimated from the Weight of 'em, and consequently the one to the

*That the Weights or Moments of Bodies consist of the Sum of their Accelerating Forces, not evident so far as from thence to affirm that Matter gravitates in proportion to its Quantity.*

the other, as 19 to 1, is, because the Matter is suppos'd Similar and Homogeneous in each, and that, what of it there is in Water, or Cork, or any lighter Body, it is of the same Form and Consistence with that of Gold, and differs in Nothing but the Figures of the Parts, and the Pores interspers'd and scatter'd about in them; for if, instead of unequal Parts of the same Matter, there was an equal Portion of different Matters in the Globe of Gold and that of Water, their Weights, which would be different where the Accelerating Force was the same, would not be proportional to their Quantities of Matter which are equal; But if an Homogeneous Matter is suppos'd, the Proof of it now is farther requir'd, before we can subscribe to the Truth of the Proportion pretended from it.

*It is not certain that all Bodies do equally descend, which is necessary to Matter's Gravitation in Proportion to its Quantity.*

§. 32. Besides this, it is not prov'd that all Bodies do equally descend, for tho' that Law may possibly obtain in those of a Groffer and Denser Nature, it is not so very manifest, that it do's likewise in such as are of a Lighter and more Active, as Æther, Fire, and the more Spirituous Fluids, unless upon this Supposition, that since it is evident in the former, it must be so in the last; because, so far as Æther or Fire is Matter, it must have the same Properties with all other Matter whatsoever, be it as Gross or Dense as it will, which is again to take it for granted, that all Matter is the same, consider'd in its own Essence, and that there is no Distinction of one Parcel from another, but that, what is prov'd of any Portion of it, equally extends to the rest.

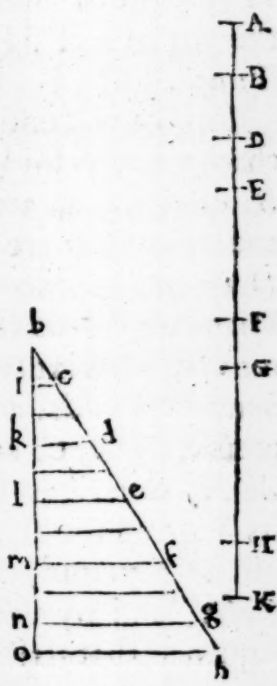
*The Doctrine of the Descent of Heavy Bodies explain'd, and their Analogy with Pendulums.*

§. 33. It will not, however, be amiss to consider upon what Grounds an equal Descent of Bodies is affirm'd, and upon what Computation their describing fifteen Paris Feet and an Inch, in a Second, depends; It is upon this Principle that descending Bodies, in their Motion downwards, are

com-



compounded of a constant Addition of the same Gravity, and of an equable Velocity thence arising, from the beginning of their Fall; Thus in the Line  $AK$ ,  $AB$  represents the Gravity,  $BD$  the Velocity, which  $A$  will have acquir'd in its Descent from  $A$  to  $B$ , the first Minute, for instance, with which Velocity it will proceed in the second Minute; but in the second Minute, it will describe, by its Velocity, a Space  $= BD$ , from its Gravity  $DE = AB$ , and therefore at  $E$  will have acquir'd a Velocity double of the former, which is express'd by  $EF$ , with which it will proceed in the third Minute; in the third Minute also it will describe a Space  $= BD$ , from its Gravity,  $FG = DE = AB$ , and upon its coming to  $G$ , will have acquir'd a triple Velocity express'd by  $GH$ , which therefore it will describe in the fourth Minute with  $HK$ , which is the constant Gravity  $= FG = DE = AB$ .



Hugen. Horol.  
Oscill. Prop. 1.  
Par. 1.

From this Hypothesis of a Body's descending with the same unchangeable Gravity, and at the end of every Interval of Time, the Velocity encreasing in a Series of Arithmetical Progressionals, is deriv'd the Figure annext, where, the Gravity being determin'd and invariable,  $bc, bd, be$ , &c. represent the Proportions of Velocity, which are as 1, 2, 3, 4, 5, &c. or, as  $bi, bk, bl$ , the Times of their being generated; from whence is deduc'd that fundamental Proposition, that the Spaces, which are describ'd by a Heavy Body descending in any Times assign'd, which Spaces are to be computed from the beginning of the Fall, are in a Du-

Mr. Halley  
Miscellan. Cu-  
riof. Vol. 1.  
P. 312. Prop. 2.



form and Homogeneous in all Bodies, according to Figure first, in the foregoing Section, and in all the Cases we can put to have an Uniform effect, Matter is still consider'd as such a Substance, that do's not, as to that property, admit of any Variation; and therefore to prove that Bodies do Gravitate, in Proportion to their Matter, from their equal Descent, is no other than to prove that Bodies do Uniformly Gravitate, upon the Supposition that they do; For tho' in any one Body that we consider, let the Proportion of Gravity be what it will, it makes no Alteration in  $AB = DE = FG$ , &c. yet, if we compare two different Bodies, and there is a different Proportion in their Gravities, in the same Quantity of Matter, that Difference must necessarily enter into the Computation.

So that in reality, we are only, by such Demonstrations as these, carry'd round in a Circle, either by supposing Gravity to be the same, and concluding from thence all Matter is; that is, by proving it Proportional to its Quantity, from the equal Descent of Bodies, or else, by supposing Matter the same, and concluding from thence Gravity is, namely, by proving it equally to descend from its being proportional to Matter.

§. 33.

§. 31, 32.

§. 35. If it is said, that these Demonstrations are confirm'd by Experiments, we need only say at present, if they really are, that they prove too much, for if they evince the Truth of these Demonstrations, they likewise prove there is no Resistance, either to the Descent of Bodies, or to the Oscillations of a Pendulum, that the Gravity of Bodies, in several Distances from their Center, is Equal, whereas it is encreas'd in a duplicate Proportion of their approach to it, and lastly, that there is no Gravitation of one Body to another, all which Forces are acknowledg'd to exist in Nature, and yet are all neglected as insignificant; that is, because they do not agree to this Abstracted

*The equal Descent of Bodies not confirm'd by Experiments.*

cted and Mathematick Reasoning we have mention'd; and why we may not as well presume and think there is something different in the real and specifick Gravity of Matter, consider'd as Matter, notwithstanding the, same Experiments, unless all Matter is alike, there is not any Reason that can be alledg'd.

*The Gravitation of the Planets in a reciprocal Proportion to their Distances, no Proof of Matter gravitating, according to its Quantity.*

§. 36. The next Argument for the Proof of Matter being proportional to its Weight, after the equal Descent of Bodies, and the equal Oscillations of Pendulums, which have been examin'd into, is that from the Gravitation of the Planets, which is in a reciprocal proportion to the Squares of the Distances from their Center, and therefore in the same Distances, as the Planets themselves, or, as the Explanation is given, as the Matter contain'd in them; which supposes, according to the receiv'd Definition of Matter, by those who argue in this way, that it is Homogeneous, and the same; for tho' we should grant, that in equal Distances the Planets do Gravitate in proportion to themselves, it is not necessary from thence to infer, that Matter do's Gravitate in proportion to it self, unless the Matter of all Planets is the same.

*The same Argument farther consider'd, and disprov'd.*

§. 37. If this yet were true, that the Matter of all Planets is the same, we cannot apprehend how their Gravitating in a reciprocal Proportion to the Squares of the Distances from their Center, or Gravitating in the same Proportion, in the same Distances, should be a proof that their Weights are proportional to their Matter; because, if we conceive all Matter to be alike, and take in the Definition of it too, that it is a perfectly passive Substance, that there is an absolute *Inertia* in it, and that it has no Resistance of its own, no more than it has Motion, in it self it can have no Force or Moment, and therefore the Force that is impress'd upon it must be computed by its own determin'd Quantity, and not by that of Matter, which is the same

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same unactive, unresisting Being, let the Mass we consider be of what Size or Dimensions we please.

§. 38. And this is evident from the Demon- *A Third Con-*  
 strations of the Proportions of Gravity, or any *futation of this*  
 Action propagated from the same Center, which *Doctrine.*  
 is diminish'd as the Spherical Surfaces are increas'd, *Miscel. Curios.*  
 to which it is dilated and expanded; but such Sur- *Vol. 1. p. 310.*  
 faces are in a quadruple proportion of the lar- *Mr. Keil, In-*  
 gest Circles of their Spheres, and by consequence *trod. Lect. 1.*  
*P. 4.*

in the same with the Circles themselves, which  
 are as the Squares of the Diameters or Semidia-  
 meters of them; that is, any Action, as Gravity  
 in the present Case, diffus'd or enlarg'd from the  
 same Center, is diminish'd in proportion to the  
 Square of the Semidiameter or Distance from it:  
 From whence it is manifest, that the Affection  
 and Property of Gravity is prov'd Independent,  
 and Abstracted from Matter, since Action is con-  
 sider'd only as dispers'd thro' several Spherical  
 Spaces, and therefore is equal whether apply'd to  
 Light, or Sound, or Heat, whose Quantity is not  
 determin'd by the Bulk of Matter, or the Exten-  
 sion of it, but by its own Force; if so, it seems  
 to be clear, that the Bulk of Matter, or Exten-  
 sion, signifies nothing to the Encreasing or Di-  
 minishing the Weight of any Body; for how  
 should Sound, or Heat, or any other Quality of  
 Body be reduc'd to the same Laws with Solidity  
 or Extension, which are as different from it as  
 can be, unless the Action in all these Cases is con-  
 sider'd, without any regard to the Subject in which  
 it inheres; and consequently a Sphere of two foot  
 Diameter is the same in its Gravitation as a Sphere  
 of one, seeing the Acceleration in both Cases is  
 alike, and nothing else is consider'd in this De-  
 monstration but the Force that accelerates.

§. 39. This Opinion appears to be confirm'd, *A Fourth Ob-*  
 from the Action being dilated, if we may call it *jection against*  
 so, in proportion to the Spherical Space increasing, *it.*  
 and

V. §. 11. ch. 4.

and therefore if it reaches the Case of Matter, we must suppose Matter to be commensurate to Space; for if it is not, it do's not fall within the Extent of the Demonstration; if it is, Space and Matter are the same, and a Plenum is asserted in the Principles that are laid down to prove a Vacuum.

From all which we cannot but think Matter is conceiv'd in an abstracted Sense, of being a sluggish and unactive Mass, that is, that it is nothing in respect of Action but what the Force impress'd makes it, which as it supposes all Matter to be the same, so it adds another Supposition to the former, that *that* Identity consists in No-Action, or, which is all one, in Nothing, till any one can prove, that it is possible for a thing to exist without some Action or other belonging to it.

*That the Satellites of Jupiter describe Orbits Concentrick to their Primary Planets, no Argument that Matter gravitates in proportion to its Quantity.*  
Vid. §. 28.

§. 40. As to the Satellites of the Planets, that those of *Jupiter* in particular describe Orbits Concentrick to that Planet, whereas if their Accelerating Forces were otherwise than in a Reciprocal Proportion of the Squares of their Distances, if the Difference was  $\frac{1}{1000}$  part only, there would be an Observable Eccentricity in their Orbits; what Proof is there from hence that Matter is proportional to its Gravitation? unless the Gravitating Force is equal to the Accelerating, upon this Hypothesis, that Matter and Space are the same, since, as it has been shewn, in the preceding Sections, there is no Connection betwixt them, excepting upon that Hypothesis.

Besides, what wonder is it, if the Motions of the Planets are calculated upon the Hypothesis of Matter and Gravity being similar, that those Calculations should be disturb'd, if Matter and Gravity were suppos'd not to be so? if it be said the *Solutions* confirm the *Hypothesis*, we answer, there is much less Reason that *Coincidences* in Solution should establish the Justness of an Hypothesis, than there is, that the Falseness of *Principles* in an Hypothesis should

should be an Argument against the Truth of its *Solutions*: We are now inquiring into the *Principles* of the present Philosophy, which we have endeavour'd to evince, are not defensible; and that the Aptness of *Solutions* can be no very powerful Argument for *Principles* that cannot be maintain'd on Reason, is sufficiently evident from what the World at this Time thinks of several Theories and Hypotheses, which have been exploded, and which yet have all pretended to as great and surprizing Accounts of Nature, as the present; since, it is easy, as in the Instance of *Leibnitz's* Vortices mention'd before, for Men of Reach and Capacity, by comparing and considering several Phænomenons together, to raise very different Hypotheses to solve the same Effects, both of which it will be impossible should be true; and if this Philosophy is not also conscious to it self of more Imperfections, even in respect of its *Solutions*, than it is willing the Vulgar should be acquainted with, he that thinks it, would be in the wrong; Altho' in the *Solutions* of the Motions of the Heavenly Bodies, if the Calculations from these *Principles* do not exactly agree with Astronomy, there is so great a Latitude given from different Observations, there are such Defects in the Observations themselves, and so many Adjustments of Calculation upon one Consideration or another, that one would be inclin'd to believe a Philosopher has a fair Chance, with a moderate Degree of Penetration, to make 'em meet at the last; a Method we shall afterwards shew is taken in calculating the propagation of Sounds.

Moreover, it is evident, that this Philosophy was first contriv'd in a popular way, that it might be fitted to the Capacity of Ordinary Readers, without the long Train of Mathematick Propositions, to which we are every where referr'd; but for prudent Reasons it was put into the Method we now see it, namely, that it might not be drawn into Dispute; however, it confesses the whole de-

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Princip. Lib. 3.  
Pref. p. 401.



pend upon the Definitions, the Laws of Motion, and the Three first Sections express'd in Book the First; which Definitions and Laws of Motion, do entirely rest upon the Supposition of an Homogeneous Matter, to which we are now reducing the present Demonstrations, which also we here farther deny, and in the process of this Philosophy shall endeavour to confute: From whence it is manifest, First, that the present Philosophy it self, only argues from the Justness of its *Principles*, and not from the Appositeness of its *Solutions*; and Second, that it was conscious how easily, in a Popular Method, it might be controverted, which, if it really carry'd Mathematick Certainty, and uncontrollable Evidence with it, it could not be; and yet, as it now appears invested with Lines, and intermix'd with Mathematick Schemes and Figures, the World is apt to surmise it has no less to support it, contrary to its own Confessions.

*The several Parts of the Planets do not gravitate in proportion to their Matter, and therefore the whole do's not.*

§. 41. The last thing we are to examine into, is, the Constituent Parts of the several Planets; for if it be prov'd, that the Planets and their Satellites Gravitate in Proportion to their Matter, (which has not been done) their Parts, 'tis said, must; on the contrary therefore, if any of these Parts do not Gravitate in Proportion to their Matter, which we shall prove, their whole Mass do's not: Thus in the Earth we inhabit, Vegetables, the Bodies of Animals, Projectiles, or any sort of Matter, which is put into a Motion distinct from Gravity, cannot Gravitate in that Proportion, and yet there is no Irregularity in the Celestial Orbits sensible from thence, that has been hitherto taken notice of.

If it be said, that Gravity in any Body continues the same, even where its Determination to the Center is alter'd, we for the present own it, as to its Inclination, and Natural Tendency; but no one, I am apt to think, will affirm, that a Body really Gravitates, and in Fact descends towards the Center, at the same time that it is thrown from it; whereas



whereas if Matter, according to this Philosophy, do's not really, and in effect, not in power only, descend and gravitate to the Center in proportion to its Quantity, these Orbits would be disorder'd; if not, if an actual Gravity and Descent is not necessary to ty down, as it were, and oblige the Planets to their several Periodick Laws of revolving, but a bare Inclination to the Center only is sufficient, without a Consequent Effect, if a Planet or Satelles was projected a Million of Miles out of its Orbit, it would be the same thing as if it circulated in it; since such a Projection would make no manner of Change in that Gravitation, which is before suppos'd capable of retaining the Planet, or Satelles, in its proper Revolution; so that it is very manifest, that as far as Bodies are in motion, Matter must, in some measure or other, really and in effect Gravitate otherwise than in proportion to its Quantity; there are several parts of this Earth are in motion, and the same may be possibly said of the other Planets, and therefore the whole Planets do not gravitate in that proportion.

To make this therefore extend to Matter in general, if Matter has any Action, or Motion peculiar to it, it will not gravitate in proportion to its Quantity; and consequently, besides the Necessity of supposing Matter to be the same in this Demonstration, as before, so again, we must likewise presume it to be perfectly dead and unactive, and to have no proper or peculiar Force belonging to it.

§. 42. From what has been already argu'd, it appears, that it is far from being a certain Truth, that Matter Gravitates in proportion to its Quantity; if this yet were evinc'd beyond Contradiction, it would still want to be prov'd, that all Matter, which do's gravitate in proportion to its Quantity, is Homogeneous and the same, since there is no Contradiction in saying, that different kinds of Matter may have different Proportions of Gravity

*If Matter did gravitate in proportion to its Quantity, yet it is not from thence prov'd to be Similar and Homogeneous, which ought to be done.*

analogous and correspondent to their several Natures, which may be distinguish'd from one another by Geometrick Quantities and Degrees, and at the same time answerable or proportional to their several Forces of Gravitation; this, we say, may be, at least, till the contrary of it is evinc'd: However, it is too plain, that in all these Labyrinths and Mazes, thro' which Philosophers have led us, there is one Thread happily runs, which has been a Direction to us to extricate, and disengage our selves from those Perplexities in which we might else have been involv'd, and that is, that these several Demonstrations depend upon this one Principle, that Matter in General is similar and alike.

*The Demonstration of a Vacuum from a Difference in Specifick Gravity, where Matter is suppos'd Homogeneous and Similar, is no more than proving the World is not full, from a Supposition of its having Vacuities interspers'd in it.*

§. 43. If so, the Demonstration of a Vacuum is very necessary and easy, because a Vacuum will be so far from wanting a Demonstration, that it will be a Self-evident Principle; for if all Matter is the same, and Matter do's gravitate in Proportion to its Quantity, then all Matter must gravitate alike; if all Matter gravitates alike, and the World is full of Matter, then there can be no such thing as a Difference in Gravitation; but there is a Difference in Gravitation, therefore the World is not full of Matter, and consequently there is a Vacuum; which comes to no more than this, with all the pompous Demonstrations that have been given of it, That there is a Vacuum, because there is not a Plenum; and there is not a Plenum, that is, all the World is not Matter, because there is a sensible Distinction in Matter, in respect of its Specifick Gravity, which would not be, if Matter was every where uniformly the same, and the World was full of it: 'But it is suppos'd that Matter is uniformly the same; that is, it is in effect suppos'd there is a Vacuum, and from thence the Necessity of one is collected, namely, by supposing it.

§. 44. We

§.44. We were, after the several particular motions observable in Matter, to consider in general the Nature of Motion it self, and to inquire, Whether that would necessarily lead us to the Assertion of a Vacuum; if it do's, it must be either on account of the infinite Resistance it will meet with in a Plenum, by which it will be obstructed in its first Effort towards a Progression, or else because of the Impossibility of an immediate Repletion of the Vacuities which are left.

*A Vacuum not concluded from the Nature of Motion in General.*

Vid. §. 1. of this Chapter.

As to the last, we answer, That in a Plenum there can be no Vacuities left, no more than there can be an Interruption of Space in one continued Vacuum, since, in the motion of a Body in a Plenum, all the Plenum as much coheres together, as the parts of Space do in a Vacuum, and it is impossible there should be a Repletion of Vacuity, where no Vacuities are made; that is, a Globe, for Instance, which is mov'd in Space, in its foremost Superficies advances into a new one, and there is so much acquir'd to the Space behind the moving Body, which it leaves, as there is lost to it before in the Space, on which it incroaches, whilst the other lateral parts of the Globe are only contiguous to Space, and pass or slide, as it were, thro' it; if this Space therefore instead of being an abstracted one of Extension, is now suppos'd to be real and material, every thing will happen as it did before, that is, the Material Space will gain as much backwards as it loses forwards, and the sides of the Globe will be continually inclos'd by it: This perhaps would be impossible, if Matter was conceiv'd to be similar and divided into parts, or at least, it could not be imagin'd how the parts should be divided so quick, and into such a minuteness, as would be requisite in the present Case, but we affirm no such Hypothesis.

*Cartes Princip. Par. 2. §. 34, 35.*

As to the First, if all Matter was the same, there would indeed be an infinite Resistance in a Plenum; but if it is not, and there are various kinds of Mat-



ter, and of differing Forces, and Æther should be suppos'd to have an infinitely small Resistance, such an Objection will be of no Validity against a Plenum, and consequently no Argument in Favour of a Vacuum; nor can it be said, if the World was full of the minutest Resistance, that taken together such a Resistance would be Infinite, and consequently Motion impossible; since the Quantity of Resistance cannot be estimated from the Quantity of Matter which resists, but from the Degree of Resistance, which belongs to any greater or less portion of it; thus a Fish may swim with as much ease, and with as little Resistance in the Ocean, as in a Pond, and in that, as in a Cistern; for the intrinsic Nature of the Fluid is to be consider'd, (and not the Quantity,) to determine its Quality and Force.

## CHAP. VI.

*Concerning Matter, and the Nature which hath been hitherto assign'd it.*

*Matter, as Philosophers have consider'd it, an Abstracted Idea.*

§. 1. **I**N the Fourth Chapter we endeavour'd to shew, that the Reasonings alledg'd for the proof of a Vacuum, depended upon a False Notion of Space; in the Fifth, that the pretended Demonstrations of one, were all founded upon a precarious Supposition of Matter's being the same; and as we before evidenc'd, that Space was only an Abstracted Idea, so we shall prove, that what has been hitherto call'd Matter, is no other, and upon that Account, that Philosophers have been deceiv'd into Misapprehensions of its being an Invariable, Homogeneous Substance.

§. 2. That Matter is not really any thing in Nature, in the Sense which has been hitherto put upon it, but an Abstracted Idea, or Conception of it.

*That it is formed and consider'd according-*



is plain from what may be collected from the preceding Chapter; besides which, all the Definitions of it, that have been propos'd, are a sufficient Conviction, that it is nothing else than a Creature of the Mind, and receives its Stamp and Character from the Arbitrary Composition or Abstraction of the Will, which takes in or leaves out what Properties it thinks fit, and when it has given to the whole what Shape it pleases, it impresses upon it the Name of *Matter*.

§. 3. Consequent to this procedure of the Mind, Matter is usually defin'd to consist of its Essence, and its Essential Attributes, and the Form of it, which is reckon'd to be a distinct Principle from Matter it self, and is made up of the whole Train of Accidents, as Hardness, Fluidity, Heat, Cold, Gravity, Levity, Colour, Taste, Smell, Sound, Light, Transparency, Opakeness, &c. We shall therefore first consider the Essence of Matter, concerning which there are two Opinions, viz. that its whole Essence is resolv'd into its Extension, as some will have it, or, as others, into its Solidity.

§. 4. Extension, according to the general Notion of it, has been already prov'd to be an Abstracted Idea, and therefore can be no other than it self; that is, the Extension in Matter, or the Extension of Space is the same, and cannot include or infer any other Properties than what are contain'd in that Idea; but our Perception of Solidity, Mobility, &c. has no kind of Connexion with that of Extension, nor by any Methods of Reasoning or Deduction can they be deriv'd from it; whereas the Intrinsic Nature, or Essence of a thing supposes, that all the Essential Properties of it are deducible from thence, otherwise if we consider an Essence, or Substratum, to be only that in which Properties inhere, without its being the Source and Fountain of them, Place will be the Essence of Matter, since all the Properties it pos-

*ing to the Will and Pleasure of the Mind.*  
Chap. 5. §. 37.  
38. 39.

*Matter, divided by the Mind into its Essence and Form, two Opinions concerning the Essence of it.*

Cartes Princ. Par. 2. §. 4.  
Rohault Cap. 7. Par. 1.  
Dr. Clark's Annot.

*Concerning the Essence of Matter in general, and that Extension is not the Essence of it.*

esses inhere or exist in it; and by the same Reason, any Accident will be the Essence or Substratum of Matter, because all the Properties or Accidents of it exist together, and in that Sense inhere in one another.

What is meant therefore by the Essence of Matter, is, that it is the Foundation of all the Qualities we perceive in Corporeal Being, and the Support of 'em, not only without which its Properties could not subsist, but as the immediate and necessary Cause of their Existence; for Motion cannot exist without Extension, and yet Extension is not the Cause of Motion, and therefore not the Substratum or Essence of it; and the Reason of our being deceiv'd in supposing Extension to be the Essence of Matter has been, because we find it is necessary or essential to it, betwixt which there is a wide Distinction.

*Solidity, not the  
Essence of Mat-  
ter.*

§. 5. Upon the same Account Solidity is not the Essence of Matter, since it is an Abstracted Idea, and is acknowledg'd to be alike in all Bodies, and from which Mobility, Divisibility, &c. are not capable of being collected by any Consequence, since to be mov'd, or divided, is quite contrary to a Solid and Impenetrable Resistance to all Motion and Division, so far as it is solid and impenetrable; for tho' Matter may be mov'd, yet not from its being impenetrable, which supposes a Quality in it, that is obstinate in preserving its own Nature, and is rather contrary to Motion, than conclusive of it.

Besides that, it is an Idea form'd by the Mind, is plain, in its being applicable, as well to mere Space, as to Matter; for what is intended by Solidity is only in general an Exclusion of all other Dimensions, out of those which any particular Body takes up by its own, which property is equally competent to Space, or simple Extension, since it is as impossible for one Primary Place to penetrate into, or possess another, as it is for one Body to enter

enter into the Nature and Composition of another, and in truth, it is to say no more in reality than this, that Matter or Space is it self, and cannot admit of any thing besides, and at the same time preserve its own Being; but such a kind of Solidity, or Impenetrability, belongs also to Light, or Sound, or Heat, or any other confess'd Accident of Body, which have all of 'em this necessary Affection to be themselves, and not to suffer an Usurpation, if we may so call it, or Encroachment upon their Beings, so long as they exist what they are, which resolves it self into an Axiom, which will universally obtain, that every thing is that Individual Identity in which it consists, and nothing less.

If it be urg'd, in respect of Matter, that it is so far Impenetrable, that its Dimensions cannot be destroy'd, or yield to any External Force whatsoever, so as two portions of Matter should be compress'd into one, we own it, whilst it continues the same Matter, as this Doctrine supposes all Matter to be, and therefore is no more than to affirm what we have mention'd.

§. 6. If there is any other Opinion concerning the Essence of Matter, it must be, that it is made up or constituted of the Aggregate or Sums of all its Essential and Accidental Properties, viz. of Extension, Solidity, Figure, Divisibility, a Capacity of moving, and being in its own Nature Unactive, of Colour, Heat, Cold, &c. But how an Individual simple Essence, from whence the Properties of any Substance are suppos'd to be deriv'd, can be those Properties is no ways intelligible; or if it were, such a Notion of Matter, which is compounded of Abstracted Ideas, as Extension and Solidity have been prov'd to be, must likewise be an Abstracted one.

*The Aggregate or Sum of the Properties of Matter not its Essence.*  
Lock's Essay, Chap. 23. §. 9.  
Book 2.

§. 7. The second Thing therefore to be inquir'd into, is the Essential Properties of Matter, two of which we have already consider'd, a third

*Figure no Essential Property of Matter.*

is



is that of Figure, which is likewise an Attribute given to it by the Mind, without signifying any thing to the explaining its Nature, or any wayt belonging to its Essence; for if Gold is the same, whether it is of a Cubical Form, or a Globular, what Reason is there that Matter should not be so too? The Figure of any thing cannot make any real Alteration in the Internal Constitution of it, and therefore, as it is unnecessary in that Respect, cannot be computed into its Substance, as that which appertains to it.

*An actual Divisibleness of Matter not a necessary property of it.*

§. 8. A fourth Essential property is Divisibility, which lies under the same Difficulties as the foregoing, since a capacity of being divided, do's not infer the Necessity of a Division, as Essential to Matter, for if Matter could not be divided, it would not be said, that it was not Matter, and if we had never found the particular Force by which a Diamond, or any other hard Body, might be separated into several parts, it would no more follow that a Diamond was not Matter, because we could not actually divide it, than, if we had not found out a Menstruum to Dissolve Mettals, as Spirit of Nitre, Spirit of Vinegar, or of Bread, Aqua Regalis, or any other Dissolvent, it would be an Argument that Mettals had not all the Properties of Matter, which belong'd to them as Material Beings.

*Mobility no more Essential to Matter, than Colour or Sound.*

§. 9. Another Capacity of Matter, and which is therefore call'd an Essential Property of it, is that of moving upon a certain Impulse, but if, what Matter is capable of is to be reckon'd amongst its Essential Properties, its Accidents ought to come into that Number, since Matter is capable of Colour, Heat, Sound, and the rest; Besides Matter being capable only of Motion, supposes it to be of a Passive Nature, which is the last Essential Property ascrib'd to it.



§. 10. As to the Inertia of Matter, it wholly depends upon this Notion, that there is Nothing in it as Primary and Essential, but Solidity and Extension, and if not, it is very plain it can have no Action of its own, unless the Ideas of Solidity and Extension include something else besides themselves, which it is evident they do not; for otherwise, if Matter was not imagin'd to consist of Solidity and Extension, why an Action should not exist in Matter, will be difficult to say, and we shall afterwards prove there do's, or why the Quantity of Matter should be measur'd from its Magnitude and Density, which we shall likewise shew it is not.

*The Inertia of Matter not certain.*  
Sir I. Newt.  
Princip. Lib. 1.  
Def. 1. 3.

§. 11. In all these several Essential Properties of Matter there is this therefore observable, that they are of no Importance to the informing us, what the Nature of Matter is, they are only Abstracted Ideas, which the Mind forms upon a general considering of Corporeal Being, and are apply'd as Universal Axioms to that thing we are willing to consider; Thus we frame to our selves an Idea of an Extension and Solidity, that are inviolable, and if there is any thing which interferes with such an Idea, we throw it out amongst the Accidents of Matter; having done this, we consider what this Extension and Solidity is capable of in the general, which by the Contrivance of the Mind is made to be, of Figure, Division, and Motion; from which we lay down these Axioms, that since Extension and Solidity, and the Capacities of 'em are Nothing but themselves, that is, are Nothing but the Ideas we have form'd concerning them, therefore all Matter is the same, because we have determin'd in our Minds what Matter is, and our Determinations are no other than what they are.

*The Arbitrary procedure of the Mind, in making Matter Similar and Homogeneous.*

§. 12. It will be said, perhaps, that the Properties which we thus Abstract in our Minds do yet exist

*The Properties mention'd &*

*bove are own'd  
to exist in Mat-  
ter, but are  
deny'd to be  
any more Es-  
sential to it  
than other  
Properties,  
which are not  
thought to be  
so.*

*From an Ab-  
stracted Idea,  
nothing can be  
infer'd, but its  
own determin'd  
Existence.*

exist in Matter, that there is at least an Extension and Solidity really inherent in it, and a Capacity of being mov'd, figur'd and divided, agreeable to the Conceptions we have form'd of them; but the Question is not, whether these Properties exist, but whether the Mind is not Arbitrary in assign- ing them, as the Genuine and Real distinguishing Properties of Matter, exclusive of the other Qua- lities we perceive in it? Whether it is not an Abstra- cted Hypothesis of Matter, from the Supposition of which we are apt to think all the Accidents of it, as they are call'd, may be Rationally deriv'd? For we do not disown, that there is Extension, or Soli- dity, or the Capacities we have nam'd in Matter, tho' this we deny, that any, or all of these put to- gether can give us an adequate Notion of it, or lead us into any Reasonings that may.

§. 13. That this Idea of Matter cannot do it, is manifest; since from an Abstracted Notion of Ex- tension, or Solidity, or Figure, &c. we can no more conclude any thing but themselves, than from the Abstracted Conception of Length, we can infer our other Ideas of Breadth, or Thick- ness; for all Abstracted Ideas terminate in the Mind, and can reach no farther than the limits it prescribes to them; And consequently Matter will remain Extended, Solid, Divisible, &c. without being able to advance one Step beyond the defi- nite and suppos'd Existence of its several Abstra- cted Qualities; Since therefore Matter, as it has been hitherto conceiv'd, is only an Hypothesis of the Mind's contriving, and made up of those Qua- lities and Properties, which it is pleas'd to take in as Essential, we are now to examine, whether such an Hypothesis is equal to, and capable of solving all the other Properties, which are thought to be merely accidental to it; But before we do this, we shall farther add,

§. 14. Extension, Figure, Solidity, Mobility, &c. *Tho' there may* are suppos'd to be the Essential Properties of Bodies; *be Properties* we have already prov'd they are Ideas Abstracted in *in Body an-* the Mind, which tho' they exist in Bodies, as is ac- *swerable to our* knowledg'd in §. 12. suitable to our Conceptions of *Conceptions,* 'em, yet we here farther say, that our Conceptions *yet our Con-* are not on the contrary agreeable to the Properties, *ceptions are* as they really exist in Nature; thus, if I have an Ab- *not always* stracted Idea of Length, or a Mathematical Line *adequate to* without any other Dimension, 'tis certain Length *the Properties* has a Being, it exists in an Extended Substance, *of Body, and* and in that Sense, there is something in Nature an- *that the Essen-* swerable to my Conception; but then no one will *tial Properties* on the other Hand therefore affirm, that this Con- *of Body can-* ception is likewise commensurate to Extension, as *not be known,* it really exists in Length, Breadth, and Thick- *whilst the* ness. *Essence of it* *is not.*

But that which we intend in this Section is to *If what we af-* enquire, that since all Philosophers, who have hi- *firm in this* therto Writ, give up the Essence or Substratum *and the fore-* of Matter, as an Arcanum, that is never to be found *going Sections is* out, which yet we shall afterwards in the Process of *true, and which* this Philosophy clearly shew what it is; I say, we *will be prov'd* shall here enquire how it comes to pass, that those *farther in the* who confess themselves ignorant of what the Es- *whole Course* sence of Matter is, should be so definitive and cer- *of this Philo-* tain in respect of its Essential Properties: If *sophy, Lock's* *Essay, chap. 4.* *8. 13. B. 1.* and *Essential* are words, which have an intimate *are so many* Relation to each other, and have a Mutual Con- *Instances of his* nexion and Dependance, it seems very Natural to *Mistakes, as* conclude from our ignorance of the real Essence *indeed his* of any thing to our ignorance also of what is *whole Essay is* really Essential to it. *one continu'd* *Error, where* *it concerns*

Nor can this Difficulty be solv'd any other way, *Master or Ma-* than by saying, that these Properties are not par- *terial Beings.* ticularly Essential to Matter, any more than others, but only to that Abstracted Idea, which has been form'd of it; and the Mind having been long ac- custom'd and inur'd to Measure all Matter by its



own Standard, takes what is Essential to its Idea to be also Essential to the Being, from whence the Idea is arbitrarily compounded.

The Question therefore which remains is, why the Mind should make such an Idea of Matter, and then settle it as a fixt Measure of its real Constitution? for which there are two Reasons.

*The Error of Homogeneous Matter deriv'd to us from the Ancient Logic and Philosophy, and by what means.*

§. 15. First, an Affectation amongst the Antients of knowing more than they really did, which in all Likelihood was the occasion of introducing those general Names of Genus and Species into their Philosophy; for to consider particular Beings had been endless, it was possibly thought, and therefore recourse was had to the ranking them under several Classes, that so they might contract their Enquiries into a shorter Compass; this humour obtaining, Matter was, amongst the rest, made to be one similar Thing, by an Abstraction of the Mind, and accordingly inculcated to the World in all the Systems of natural Knowledge, that were propos'd to it, and how unwilling any Age is to unlearn what a Former has Taught them, is too evident in Experience.

However, as this Notion of Matter is only deriv'd to us, from the Ignorance of those who went before us, so we cannot but think the present Age will, together with its other great Attainments, endeavour to assert it self from an Error into which it has been, by the Authority of the many preceding, so apparently abus'd.

*A second Reason for its obtaining in the present Philosophy.*

§. 16. Another reason, and which is the principal Cause of this Abstracted Idea of Matter's prevailing in the Modern Philosophy, is the endeavouring to explain the several Phænomena of Nature, by the most simple Principles; For since, the true Essence of Matter could not, as it was apprehended, be fully understood, the next Thing to that, was to find out and contrive such general

Affe-



Affections in it, as might give a Solution to the  
rest.

And from hence is deduc'd the whole Corpust-  
cular Philosophy, and which has been already suf-  
ficiently confuted, (if we were to say nothing  
more) from the incompetency of an Abstracted,  
or several Abstracted Ideas put together, to be  
the Foundation of a real Knowledge of Things, as  
they exist in their full Latitude and Extent.

We must likewise subjoyn, that from hence re-  
sults the Difficulty of finding the Substratum of  
Matter; for when Philosophers have made it to con-  
sist of Arbitrary Properties, and which depend  
upon the Pleasure and Abstraction of the Mind,  
as Extension, Solidity, &c. are only such, it will  
be a necessary Problem how these Properties are  
connected together, and the Solution of it will be  
impossible, if they are only Creatures of the Mind,  
for the same Reason, that one Act of the Will  
has no Connection with another; Since, if we re-  
solve that Abstracted Extension shall be one Pro-  
perty of Matter, and again, resolve that Abstra-  
cted Solidity shall be another, then Divisibility,  
&c. what other Agreement can they have more,  
than what is betwixt such Resolutions of the Will?  
Betwixt which there can be none at all, whilst  
the Mind is suppos'd to act as it pleases.

We shall lastly say, that besides the Difficulty this  
Doctrine raises in respect of the Substratum of Mat-  
ter, it also furnishes us with no Account even of  
our Sensations of it; for as we have said before in  
Relation to Space, so we likewise affirm here, that  
it would be impossible for Matter to be Seen or Felt,  
according to the present Notion concerning it; For,  
if it has Extension in the Abstract, which way can  
an Abstracted Idea impress it self upon the Mind  
from without, which is Originally in it? or, if  
it has Solidity, how shall the Mind perceive that  
Solidity? not by Feeling, for what it Feels, is Re-  
sistance

istance, whereas Solidity or Impenetrability is the not entering of one Dimension of Space or Matter into another, which is not Felt but Conceiv'd; and in general, it is absurd and irrational to think, that Matter should give us any Sensations of it self, if it is compounded of Abstracted Ideas; unless a Perception or Creature of the Mind, which is confin'd to it self, can supply us with Sensations, which are deriv'd from something External to it, which is in Terms a Contradiction, and any one may as well say, he Sees or Feels Thought, as such Properties of Matter, which are all resolv'd into it.

*The next thing to be inquir'd, is, what Solutions the Hypothesis of Homogeneous Matter gives of the several Phenomenons of Nature.*

§. 17. As we have therefore examin'd into the Truth of this Hypothesis of Matter's being the same from the justness of its *Principles*, so we shall now enquire into it, by considering the Reasonableness of its *Solutions*; Matter, as is said before is an Extended, Solid Substance, Divisible, and by Consequence has Figure, and is capable of being mov'd; As to what respects the Solution of the Appearances in Nature, that is now to be known.

## CH A P. VII.

*Concerning the Solution given, from the Supposition of a Similar Matter, of the chief Properties of it.*

*Extension, Solidity, &c. ought in a true Philosophy to be accounted for, as well as*

§. 1. **T**HE defect of this Hypothesis of Homogeneous Matter begins soon, since it cannot Account for its own Original and Essential Properties, which, instead of accounting for, it assumes; for there is no Solution given of what is the Cause of

of Extension, or Solidity, or Divisibility, or Matter's being capable of Motion; all this is suppos'd from our observing there are such Qualities in Corporeal Being; and by the same Method of supposing from an Observation of what in Fact exists, Matter is capable of Heat, of Colour, of Sound, or whatever Accident it is, and wants no other Explanation of its Nature than Solidity or Extension do's.

§. 2. It will be therefore alledg'd, that from an Abstracted Notion of Colour, or Sound, or Heat, or Taste, or Smell, or whatever other Accident there is of Matter, we cannot, upon any of these Hypotheses, solve the Properties or Affections of Body; To which it is answer'd, that from the foregoing Section, that other Hypothesis of Essential Properties cannot give a Solution of those Properties, which are call'd Essential, as these Accidental Properties cannot of themselves, and since both Accidental and Essential are upon the same Level in this respect, we are farther to see, whether or no the Hypothesis of the Properties before-mention'd, and which are presum'd Essential to Matter, gives any Manner of Solution of the Accidents of it.

If not, there will be no imaginable Reason for us to make them more necessary to Matter, than any other Qualities we find in the same Substance, because, if they are not the Foundation of the rest, there will be no better a pretence to establish a Collection of these Essential Properties for a Standard of Matter, than a Collection of these together with the Accidental ones; for, in both Cases, we shall only affirm such an Idea of Matter, which is not answerable to one portion or other of it, which our Experience or Senses tell us has a Being in Nature; Thus, if Extension, Solidity, Figure, and Motion, do's not infer Colour, Heat, Sound, &c. it will be as defective, when such a Definition comes to be apply'd to a Colour'd, Hot,

*Sound or Colour, which is not done in the present.*

*At least the Essential Properties ought to furnish us with a Solution of the Accidental, otherwise the Accidental will have an equal claim to be Essential with those which are term'd so.*



or Sonorous Body, as if we should take Colour, Heat, and Sound into the Essential Properties of Matter, and apply that Idea Universally to Bodies, which are not endu'd with those Affections.

*The Essential Properties of Matter cannot explain the Accidental ones.*

§. 3. It has been said, that these Essential Properties of Matter cannot furnish us with an Explanation of themselves, but how they should give us a rational account of the Nature and Existence of any other Property of Being, when their own is unknown, is not very easily comprehended; for instance, supposing we had a Mind to explain what Colour is, and had reduc'd it to small and figur'd Corpuscles, acted by a certain and determin'd Motion, we should not be much the Wiser, if we could not tell what the Nature of these Corpuscles were, it would be the same, as if, in giving the Solution of the Mechanism of a Clock, we should resolve it into the Figure and Motion of the Wheels, without knowing the intimate Spring, by which the regular Circuits, they make are caus'd and produc'd.

*The Problem of Cohesion so far from being solv'd by this Philosophy of Matter, that it is occasion'd by, and deriv'd from it.*

§. 4. From this general failure in the Hypothesis of all Matter being the same, we shall descend to its Defects, in Relation to its particular Solutions, and the first we shall take Notice of, is that of Cohesion, a property of Matter, which seems to be as Essential to it, as any that has been nam'd; for let us contrive as many Causes, as we can think of, to explain it upon this Presumption, that there is nothing originally in Body, but Extension, Solidity, Figure, and Motion it will still remain an inextricable Difficulty in Philosophy, tho' we make what Composition, or use of these Properties we please; for whilst we consider in Matter nothing, but little figur'd and moveable Parts, supposing we assign'd the Pressure and Gravity of the Air, or whatever other Cause of Cohesion, this Question will still return upon us, how, and which way those Parts cohere.

And



And indeed the Hypothesis of Matter being Similar, and from thence Endeavouring to solve every Thing by various and differing Combinations of Figure and Motion, is so far from removing the difficulty, that it seems to be the very rise and occasion of introducing it into the present Philosophy; Since, when Men have taken abundance of Pains to divide Matter, and to cut and carve it out into as many Arbitrary Shapes and Figures, as may be thought subservient to the Phenomenons they would explain, it is very natural to enquire, what Method is to be taken to put them together again; In the mean time, it is an Argument of the Wisdom and Sagacity of such an Hypothesis, that in the first step it makes towards the solving the several Problems of Nature, it do's it, by laying the Grounds and Foundations of one of the greatest in it.

§. 5. From whence it is evident, how well Philosophy has been employ'd in examining into that Question, concerning the Infinite Divisibility of Matter, when the Divisibility of it in general, consider'd as an Essential Property, has been the Cause of such Confusion in it; for to what purpose do we lay such a mighty stress upon Matter's being Divisible to Infinity? Unless upon this Account, that we may have Parts small enough to escape the grossness of our Senses, and which therefore we may argue upon as we please, and make use of them to what purposes and intents we have in View, of solving those things we are desirous the World should think we know; For otherwise, what signifies it whether Gold or Water is infinitely Divisible, or not? The Nature and Essence of both in a Globe of a Foot, or an Inch Diameter is the same, and will be so for that Reason, tho' its Diameter were diminish'd to the Millionth, or to an Infinitesimal Part of either.

*The Divisibility of Matter, whether infinite or not, of no importance in Philosophy, nor yet the Figures into which it is divided.*

Rohault. Phys.  
Cap. 9. Par. 1.

Mr. Keil's In-  
troduct. Lect.  
5. P. 40.

It is by Experience, and Natural Deductions from it, evident, that a Cube of Gold, whose Side is only in Length about an Inch, may be divided into above 1200000 Square Lamellæ parallel, and equal to the Basis of the Cube, the Thickness of one of which is the same with that which lies upon Silver Thread Gilt, and even common Leaf Gold, is computed to be no less in its Thinness, than the 300000 part of an Inch; and by a third Calculation it appears, that the Contents of a Cubical Inch of Gold, may be divided into above 47 Millions of parts, which will be all Visible, and yet in any of these Divisions, Gold remains exactly the same, without any kind of Alteration, excepting in its Magnitude; for it is impossible that the Minuteness of any thing should change the Nature of that thing we consider, upon the same account as Motion or Extension cannot, by any Diminution, become other than what it is, unless in its Quantity or Degree.

We do not, however, in this Section deny, that Matter, consider'd as an Extended Substance, is infinitely Divisible; what we affirm is only, that whether it is infinitely Divisible or not, it is of no significancy to the explaining the Nature of it; since all, that any actual Division can do, is to separate Matter into several Figures, but Figure, in the Common Sense of Mankind, is only certain superficial Limits, prescrib'd to Body by such a Division; and which way a Superficies can enter into the real Constitution of that which it only contains, and is the Term and Boundary of, is no more intelligible, than how the Shape of the Letters I am now Writing, should inform us of the Nature of the Ink, of which they consist, and with which they are wrote.

Gravity not  
explain'd upon  
the supposition

§. 6. Another Phænomenon, which this Abstracted Hypothesis of Matter is to explain, is Gravity, and the Specifick Differences of it; In both which

which respects it is again deficient, for tho' it labours to give us an account of the Descent of Bodies, by the Revolution of the Earth, which by that means is said to dash, as it were, the Æther from its Surface into the superior parts of the Atmosphere; and that, being thus actuated, they Violently thrust down thence any gross Matter they meet with, to fill up the Vacuities they have left, yet such a Solution is altogether unsatisfactory, to those, at least, who will not allow a Plenum, upon the Supposition of which this Reasoning depends.

And in general there is this manifest Imperfection in it, that the same cause which is assign'd for Bodies descending, is an Argument why the parts of the Atmosphere, which are contiguous to the Earth, should not ascend; since in a Plenum, where all Matter is suppos'd to be similar, except in the minuteness of its parts, there will be an equal Resistance to the rise or Ascent of the Æther, from the Impressions of the Earth's moving, as there will be to the Descent of any heavy Body in the Air from the Impressions of the Æther's moving; And therefore the Æther and heavy Body in the Air, will jointly ascend, or both keep their fix'd and determin'd Stations, and consequently, in both Cases, there will be no Gravity, but the Body in the Air will retire from the Earth, together with the Æther, instead of tending towards it, or hang suspended in it.

Besides, if there is no Difference in Matter, as this Doctrine takes for granted, we should see all gross Bodies, as well as Æther, by this Motion of the Earth, to be forcibly hurl'd from their Center to very great distances, since Bodies Gravitate at such Distances; the Cause of which is the Æther's reaching thither from the Impressions of the Earth, and since Æther is of the same Matter, according to this Hypothesis, with that of the grossest Bodies, and the World is full of it,

*of a Similar and Homogeneous Matter.*

Cartes. Prin-  
cip. Lib. ult.  
§. 20. 21. 22,  
23. *Miscell.*  
*Curios. Vol. 1.*  
P. 304.

Farther, Gravity has been thought to be prov'd to extend to the Orbit of the Moon, whereas it is inconceivable, that any Effects from the Motion of the Earth, should be propagated to 60 Semidiameters from it, being the Distance of the Orbit, which by Computation amounts to several Thousand Miles.

If it is said, in order to solve Gravity, according to the more Modern Philosophy, that Gravity is an Essential Property of Matter, the Demonstrations of it, as we have before evidenc'd, depend upon the Supposition of this Similar Matter we are now confuting.

Moreover in the Hypothesis of a Similar and Homogeneous Matter, how is it possible from the Mind's Abstraction, of Extension, Impenetrability, Figure, &c. to deduce Gravity, which is an Actual Force in External Nature, and cannot be deriv'd from an Hypothetick Matter, which is ascertain'd and determin'd by the Mind only? Since we may as justly, and as truly, conclude Gravity from thinking, as from such a Matter, which is wholly resolv'd into it.

*The Difference of Specifick Gravity unaccountable from a Similar Matter, and upon the Supposition of a Plenum.*

§. 7. However, if this Hypothesis of an Extended, Figur'd, Solid, and Moveable Substance, was capable of explaining Gravity it self, it would still fall short of Accounting for the Specifick Differences we perceive in it; since all Matter being the same in its own Nature, and the Gravity of each Parcel of it, being granted to be so too, there remains nothing to distinguish the Gravity of one Portion of Matter from that of another, unless that one Body is proportionably less heavy as its Vacuities or Pores are greater, which, as it is a Demonstration in Terms, against those who affirm a Plenum, and at the same time a Similar and Homogeneous Matter, so we shall shew to those who assert a Vacuum, and the like Similar Matter, that Specifick Gravity cannot be maintain'd upon the Supposition of such different Interstices.

§. 8. The



§. 8. The *Florentine* Experiment is sufficient to confute this Notion, by which it is prov'd, that if you fill a Thin Large Vessel of Silver with Water, well cool'd with Ice, and screw the Cover on close, and then Hammer it gently every where, the batter'd Silver (being not so ductile as Gold, which by being Hammer'd might enlarge its Capacity) lessen'd and compress'd the Dimension of the Vessel; notwithstanding which, the Water was not condens'd, but at every stroke swet through the Vessel, as Quick-silver, when press'd thro' Leather, Spirits out in little Drops: It is likewise observ'd, that the Weight of Silver is to that of Water, as 10, or 10 and  $\frac{1}{2}$  to 1.

If therefore the Difference of these two Bodies, in their Specifick Gravities, is owing to the Void Spaces in them, the Pores they contain will be in a reciprocal Proportion to their Matter, which is said to be as its Weights, namely, the Vacuities in Water, will be to those in Silver, as 10 or 10 and a  $\frac{1}{2}$  to 1; Let us now suppose the Pores of the Water and Silver to be equally dispers'd thro' the Substances of each, which is a reasonable Presumption, since there is not any evident Cause can be assign'd, why one Piece of Silver or Water is not similar and homogeneous to another; if so, there will, at least, in every Portion of Silver and Water be 10 Parts of Empty Space in the one, for 1 Part in the other, and reciprocally in the Matter of both; from whence it necessarily follows, that either 10 Parts of Space must encompass the one Part of Matter in Water, or the one Part of Matter must be so dispos'd into a Thin Spherical or Cubical, or some other figur'd Surface, as to include the 10 Parts of Space, which are the only two Cases that can possibly happen, or what in the Result will be Analogous to them; if we suppose the last, since the Water is experienc'd to pass thro' the Pores of Silver, a part of Water, which incloses

*The Difference of specifick Gravity inexplicable, from the same Principle, and upon the Supposition of a Vacuum, prov'd from the Florentine Experiment.*

Lock's Essay, Chap. 4. B. 2.

§. 4. Acad. del Cimento, P. 117. Exp. 3.

Mr Lowthorp's Abridgment Philof. Transf. Vol. 1. P. 613.

10 parts of Space, will be capable of being forc'd thro' a *Meatus* of Silver, which is 10 times less, and yet preserve its own Dimensions of being 10 times bigger, which is impossible; for if we can imagine these Spherical or Cubical, or any other Figures, to be broken from the violent pressure, there would be a sensible Condensation of the Water; on the other Hand, if 10 parts of Space surround one of Matter, the Water must be evidently condens'd, contrary to the Experiment.

*Provd also  
from a Comparison  
betwixt  
Silver and  
Cork.*

*M<sup>r</sup> Lowthorp's  
Abridgment  
P. 612, 614.  
Vol. 1.*

§. 9. If this were not enough to confute the foregoing Hypothesis, let us take another Instance of Cork, that is of a close Contexture, without any sensible Vacuities, and compare it with Silver, the Specifick Gravities of which Bodies are as 1 to something more than 44; and therefore, according to the Supposition of similar Matter, there will be 44 Parts, at least, of Space in Cork, to one in Silver; consequently, seeing there is no appearance of Pores in Silver to the naked Eye, or, which is the same, seeing they are so very minute, that the vast Disproportion of them to the Matter, with which they are intermix'd, makes them impossible to be discern'd; by a like Argument, on the contrary, there should be no Matter visible in Cork, the Pores of one Body being in a Reason of Equality to the Matter in the other; unless we affirm, that Space has not the same Advantage of being perfectly seen and discover'd, as Matter has, and that Nature uses the wise Art, when she pleases, of concealing her own Emptiness.

We must farther observe, that by diminishing the Parts of any Body, by what foregoes, its Resistance is not much impair'd, and consequently the Body do's not take up much more Space than it did before that Diminution; from whence it follows, that by an infinite Division of the Parts of Cork, there could not be any great Assistance from thence, to the filling up and contracting these large Vacuities.

§. 10. We

§. 10. We do not deny (and therefore we would not be here mistaken) that there are any Pores in Matter; and in Bodies of almost the firmest and solidest Consistence, as Silver, there are, it may be, Vacuities interspers'd in it; but this we cannot but think and believe, that those Pores no more enter into the real Constitution of Silver, or Matter in general, than the wide Interstices we find in Cork, can be computed into the Substance of it; for why, Space, being diminish'd, should by that means become any thing else but Space, is no more imaginable than how Matter should, which we before consider'd in the Section concerning the Divisibility of it.

If it be here said, that each minute part of Silver has still other Pores, and the parts of that still others intimate to them, and that therefore Pores do belong to the Composition of the least parcel of it, we can possibly apprehend; we answer, that either there will be a Particle of Matter in Silver that is perfectly solid, or not; if not, we shall resolve the whole Mass into mere Space; if there is, then since Space has no Weight, all that Space, which is excluded from this Particle, do's not diminish any thing of its Gravity, which therefore will be to an equal portion of Water, according to §. 8. as 10 to 1, and consequently, without the least Pore or *Meatus*, will preserve its own specifick Matter of Silver.

If, in Favour of the Doctrine of Pores, it is farther alledg'd, that Microscopes abundantly prove it, we answer, that thro' Microscopes we discover Matter, as well as Pores; and therefore the Vacuities will signify no more to the Explaining that which is not Vacuity, than the Large Spaces in Cork, which are visible to the naked Eye, can be of any Importance to the informing us what the Nature of Cork is; besides, we must take the Liberty to add, in respect of Microscopes, that it is not impossible but they may change the true Appearance of

*Pores in Bodies of little or no significance to the internal Nature and Constitution of them.*



of Bodies, and represent more Vacuities to us, than there really are; for since it is the Nature of them to make several Opake Bodies look transparent, it is not certain, that they may not cause some solid Parts to appear like a porous, uncolour'd Substance, or that, at least, they may not magnify a porous Substance in greater proportion than they do a solid one.

*The Different Divisibility of Matter, not solv'd from the Hypothesis of its being Simi-*

§. 11. Next to Gravity and Cohæſion, we shall examine what account this Arbitrary Collection of the Essential Properties of Matter gives of its being Divisible; that is, allowing Matter to have that Principle, and without enquiring how it comes to be an Universal Affection in it, which, as we before said, this Hypothesis no ways explains, and only presumes: The Question now is, Whether it is a Supposition, answerable to what we experience in Nature, and will solve the Phænomenons, which are obvious, and respect the Divisibility of Matter?

'Tis plain, that Water is more easily divided than Cork, Cork more easily than Lead, and Lead still more easily than Gold, Silver, or a Diamond; and so in other Bodies there are different Degrees and Proportions of Force, requisite to separate the several parts of them; It is again affirm'd in this Hypothesis, that the Divisibility of Matter is the same, for what is meant by Divisibility, is a general Capacity in Matter of being divided, it is an Abstracted Idea in the Mind, and is constant and fix'd there as an invariable thing, which can never solve the different Capacities in Matter of being divided, that are evident from common Observation.

*The Different Extensions of Matter not solv'd from this Philosophy.*

§. 12. And the same Reasoning obtains also in respect of Extension, since, tho' we should not enquire into the Nature of it, but resign it to this Philosophy, as an Original Property of Matter, which we must not venture to ask the Cause of, we yet, from such a Concession, cannot perceive how an Abstracted Notion of similar Space and Extension can furnish us with a just Solution of those va-

rious



rious and differing Extensions, that are impress'd on our Minds from Body; for, Abstracting from the Colour or Brightness, or Opakeness of Gold, Water, or Wood, I would fain know from any one, who truly contemplates those Bodies, Whether he do's not see a manifest Difference in the surfaces of them? Whether he do's not plainly see a closer Connexion and Constipation of parts in one than in another, and whether, if he had never by his Feeling experienc'd a sensible Distinction in their Resistances, he would not have concluded, notwithstanding, that they were not the same Bodies, as to their Extension?

I am satisfy'd there is no Abstracted Idea lyes so settl'd and confirm'd in our Minds, as this do's; and perhaps it will be hard to persuade Men, after such a general use made of it in Philosophy, and its being inculcated upon us, in all the Systems it has propos'd, as an unchangeable Quality in Material Beings, that there is any real Difference; we must therefore be patient till the World has learn'd to think otherwise, and can get quit of those prejudices it has unwarily imbib'd from its Abstractions, and which are only deriv'd to us from the ancient Compilers of Logick, and the comprehensive Methods of Knowledge, they were so kind to invent for us.

For, Let us suppose a Person plac'd at some distance from Bodies, which he never felt, so as yet they should be within his view; as, for Instance, Gold, and Cork, or Water, and Air; he finds there is an interval lying betwixt the parts of each, common to all of 'em, that there is a Transparency both in Water and Air, and a different Colour in Cork, and Gold; but would there be nothing else to fill the Eye, besides Interval, Transparency or Colour? if not, Air and Water would appear the same, and there would be nothing to distinguish Cork from Gold, unless that the one was yellow, and the other brown;

brown, since, as to what respects the solidity of the parts or their resistance, *that* is, in the present Case, unknown; it is therefore evident, that in those Images of Extension, which are painted upon our Minds, there is a plain Distinction, and if so, that a general, similar and abstracted Idea of it cannot be sufficient to explain the varieties we perceive in it.

*The Solidities of Bodies not to be deduc'd from the present System.*

§. 13. We may also conclude from hence, that Solidity, as it exists in Nature, cannot be deduc'd from the Abstracted Idea of it; we have already explain'd what that Abstracted Idea is, which terminates in one general Notion, that Matter excludes every thing from possessing its own Dimensions, but what this signifies to the explaining the real Solidity of Matter, which has a different Resistance to any thing which endeavours to possess its place, we do not, nor cannot apprehend; thus Gold, or Copper, has a Resistance, different from Water, to any other Matter, which would enter into the place it takes up.

But that which seems very surprizing, in this abstracted Hypothesis of Matter, is, that it makes it, in the general Notion it forms of it, Divisible, and yet, in another general Notion it frames, to be so perfectly solid and obstinate, that nothing can penetrate into it; we speak of general Notions, and whilst they are consider'd as such, it is impossible for any Being to be divisible, and impenetrable at the same time; for supposing any one should say, a certain Piece of Gold in particular is impenetrable, that nothing can enter into this Gold, whilst it is Gold, that it will preserve its own Dimensions, as it is Gold; should the same Person affirm, that, as it is Gold, in its own Nature it is divisible, he could not be thought, in any Rational Man's Sense, to assert any other than a Contradiction.

*The Difference of Pores in Matter, viz. Divisibility, Solidity, and Extension, it dy, incapable of*

§. 14. As to these three last Affections of Matter, viz. Divisibility, Solidity, and Extension, it may be possibly answer'd, That the different Extension,

Extension, Solidness, and Divisibility of the Parts of it, is owing to there being more or fewer Pores interspers'd in the same Similar and Homogeneous Substance; we shall not reply that Matter in this Philosophy is proportional to its Gravity, and therefore, as Specifick Gravity was before prov'd §. 8, 9, 10, to be a Phænomenon incapable of being solv'd by the different Pores in Body, so Extension and Solidity, or Divisibility must be.

What we shall say at present is, that if the Different Divisibility of Matter depends upon the Difference of the Pores, or Vacuities contain'd in it, Matter, in its own Nature, is not Divisible at all, and it is only Space that is so; and for the same Reason, if the Difference of Extension, or Solidity, do's likewise depend upon the Difference of the Pores or Vacuities in Matter, it is not Matter that is Solid and Extended, but Space that is so.

If therefore any Vacuities or Interstices give an Increase, or Diminution to real Solidity, or Extension, as it exists in Nature, the other being only Abstracted Ideas, all the real Solidity and Extension will be deriv'd from Space, which is absurd; but we have already consider'd the Unreasonableness of making the Difference of Bodies to consist in their different Pores, and what is here alledg'd is only a Confirmation of it.

§. 15. Matter being suppos'd to be still the same, we are, after what has been said, to account for the Motion of it: That it is capable of being mov'd, is not any ways evidenc'd from Extension, Solidity, Figure, or Divisibility, since these are all Unactive Qualities in Matter, and it cannot be from Mobility, because it is the same as a Capacity of being mov'd; this therefore is taken for granted in the Foundations and Elements of the Modern Philosophy; nor yet do we enquire into the Cause of Motion, which we shall afterwards prove to be that Almighty and Sovereign Being we adore:

The

*solving the different Divisibility, Solidity, and Extensions of it.*

*Mobility not explain'd by the Corpuscular Hypothesis, nor the several kinds of Actual Motion, which depend on that Capacity.*



The Question only here is, Whether Body can be prov'd to be capable of being mov'd by any Property in Homogeneous Matter, excepting by assuming the very property to be prov'd?

Besides, if this could be done, the several Motions, which we every where see in Nature, could not be explain'd, by one Abstracted Idea of the Mobility of Matter in general; First, because the Capacity of being mov'd do's not infer an actual Motion, and second, because, if it did infer an actual Motion, it could never give a Solution of the different Motions we plainly find from Experience and Observation: The Motion of Fire is different from that of Wind or Air, and both from that of Gravitation; but how we shall solve these different Motions from an Idea of Mobility, or even Motion in general, is still a Problem that will require other Principles than those of the present Philosophy to explain it; since it is impossible to do it upon the abovemention'd Abstracted Notion of Matter.

*The Method of Philosophers in solving the Active part of Nature, from the foregoing Principles.*

Cartes Princip. Par. 3. §. 52, &c.  
Rohault Cap. 21. Par. 1. & Par. 3.

§. 16. And therefore it is, that when Philosophers come to give their Explications of the Active part of Nature, they are oblig'd to form as many different Hypotheses as there are Phænomenons to be solv'd; and consequently we find 'em putting the Matter, which they have arbitrarily contriv'd, into such a motion as shall be subservient to their purposes and designs; some parcels of it they set to revolve round upon their own Centers, others are to strike into Pores, which they have made for them, like so many Wedges, a third sort, which is their subtile Matter, is to be ready at hand, to insinuate it self into certain Vacuities upon any command, and therefore has not its stated and determin'd Motion, but what Motion the Philosophers think fit to give it for that Time.



Besides this, there are a kind of Valves invented to open and shut, as occasion shall be, in order to explain several Appearances in Chymistry, which otherwise seem to be unaccountable; and indeed, to form a true Idea of the Absurdities of a Similar Matter, it will be necessary to look into the Accounts, which the Professors of that Science afford us, of the great and wonderful Phænomenons it exhibits to us.

§. 17. From what has been said before, concerning Divisibility and Figure, and from what has been now call'd, concerning a Capacity in Matter of being mov'd, it is evident, that Philosophers have not made these the Essential Properties of that Substance, because they really are so, but because they are Essential to their using Matter as they please; for Instance, when they could not assign any Reason for Matter's being Divisible, or Moveable in its own Nature, they lay it down as certain from Fact and Experience; and when this is granted them, they without any farther Leave, assume to themselves a power of Shaping it into what Figures, or contriving into it what particular Motions they shall think convenient; but if such a procedure is allow'd of, to take different Suppositions upon every Phænomenon, or Appearance in Nature we are desirous to account for, Philosophy will be an easy Science, but whether it will be esteem'd, by any Rational Man, any other than an Ingenious Romance, will scarcely admit a Question; for by the same Reason, that we may make use of different and arbitrary Suppositions to solve different Phænomenons, we need not go far for an Explanation of every thing; because if we see Matter extended, we may suppose Extension to belong to it; if solid, Solidity; if variously mov'd, we will likewise suppose there are different Motions in it; and from these several Hypotheses we shall, no doubt, be able to give a wise and rational Account of these Appearances,

Lemmer's  
Chymistry.

*Divisibility,  
Mobility, and  
Figure, why  
made particu-  
larly essential to  
Matter.*

pearances; and yet, in the last Result, the Modern Philosophy tells us no more than this, by what is evident and plain from this and the preceding Section, and will farther be so, when we consider the Qualities of Matter, which are call'd Accidental, which we shall do in the ensuing Chapter.

## C H A P. VIII.

### *Concerning the Solution given from the Corpuscular Hypothesis of the Accidental Qualities of Matter.*

*The Accidental Properties of Bodies no better explain'd, from Similar Matter, than the Original Qualities of it.* §. 1. **WE** have prov'd the Hypothesis of Similar Matter is not capable of solving the Original Properties of Bodies, upon any Concessions whatsoever, unless such as grant and conclude the Properties which were to have been solv'd by them; our next Enquiry is, Whether it has better consulted the Explication of the Accidental Qualities of it, which we shall now endeavour to evidence it has not.

*Of Hardness: That the Hardness of the Constituent parts of Bodies is not solv'd.* §. 2. Let us first consider Hardness, as distinguish'd from Softness or Fluidity, which is said to consist in Quiescent parts, and which have a close Connexion with each other, without any Interruption from an Intervening Subtil Matter; so that those Bodies that have the most parts at rest among themselves, and are united, or joyn'd to each other in the greatest number of Points, are the Hardest: We do not now enquire how this Account of the Hardness of Bodies, granting it were true, gives the least Solution of the Hardness of the Constituent parts of them, which it can't possibly do; but supposing the Hardness of the Constituent parts of them, we are to know, of what Significancy such a  
Sup-

Rohault Par. 1.  
Cap. 22. §. 9.  
Cartes Princ.  
Par. 2, §. 54, 55.

of Supposition can be to the Explaining the Hardness of such Bodies.

§. 3. In the mean time, we cannot here but observe, that, in the Notion of Similar or Homogeneous Matter, Solidity is reckon'd amongst its Essential Properties, and therefore it is suppos'd to be the same as hardness, or not, in the present Solution; if it is not the same, it will be impossible to make any Body hard, from a Composition of Parts which are not so, or, which is the same, from Impenetrability to deduce Resistance, which is penetrable; if Solidity and Hardness are the same, we have no occasion for any Solution of Hardness, because it is the same as Solidity, which is a Property, it seems, Essential to Matter, and ought not to be accounted for.

§. 4. Besides, Quiescence and Contiguity are two new Properties superinduc'd to the first stated Notion of Matter, in order to explain the present Difficulty, since neither of 'em can be deriv'd from Solidity, Extension, Divisibility, or Mobility, for a Body may be all this, and yet as to its Parts not Quiescent, or Contiguous; because the Notion of Similar and Homogeneous Matter supposes Solidity, Extension and Divisibility, to be several Uniform and Abstracted Ideas, without considering the Parts of Matter in an actual Division; for, whether Matter is, or can be, really divided, or not, the Properties of Solidity or Impenetrability, of Extension, of Mobility, &c. will still obtain; whereas Contiguity supposes the Parts to be actually divided, and after that Actual Division, to be quiescent one amongst another, which has no Relation to, or any Connexion with, an Abstracted Idea of Matter in general.

From whence it is apparent, that the Hypothesis of Similar and Homogeneous Matter is chang'd by this Accession of foreign Qualities, and that therefore it do's not give us an Adequate Idea of

*An Argument against the present Account of Hardness, from a Comparison of it with Solidity.*

*Contiguity and Quiescence cannot be deriv'd from the Original Properties of Matter.*



Hardness, as it exists in Nature; seeing the Defects it labours under, Philosophers, as here, so all along, thus arbitrarily, upon every Emergence, are oblig'd to supply from their own Fancies and Imaginations.

*Contiguity and Quiescence either upon the Supposition of a Plenum, or a Vacuum, incapable of giving us a Solution of Hardness.*

§. 5. If, notwithstanding, we were to pass over these Fundamental Mistakes, it will be still impossible to solve the Hardness of Bodies, from the Quiescence and Contiguity of the Parts which compose them; for granting the Parts of Matter to be brought together, by some unknown Magick Power, after their Original Division, and granting also those Parts to be at rest, that is, supposing Quiescence and Contiguity, which, we say, are New Principles affix'd to Matter, that were not included in it before, and want as much to be explain'd as the Hardness which they are brought to assign a Cause of, how yet could Contact, and a Rest of Parts, be a Reason of Hardness, which is a Resistance of such Parts to their Separation?

They who affirm a Vacuum cannot allow of so Extravagant a Solution, since Space would then be the hardest Body in the World, as its Parts are imagin'd to be immoveable, and continu'd to each other; for why, the Quiescence and Contact of the Parts in Solidity, abstractedly consider'd, should not be the same as the Quiescence and Contact of the parts of Space, abstractedly consider'd, no Reason can be given; since not the Internal Constitution of the Parts, but the Joyning together and mutual Relation and Position of the Parts themselves (which is the same in Quiescence) only enters into this Hypothesis.

Those who assert a Plenum must likewise find this Weakness in the Solution, that, all Matter being in its own Essence the same, according to their Supposition, and all Nature being perfectly full of it, the Subtilizing its Parts cannot be of the least Importance one way or other, in the Explicating any Phænomenon; for thus, if we take a Square Portion of



Matter, Chap. 5, §. 23, and conceive it to be divided into more or fewer parts, the Area will be still the same; and if so, since there is an Universal Contact in all the parts of Nature, which is suppos'd one solid Mass, there cannot be the least room for Motion, one Body will resist as much as another, Contact and Quiescence will go together, and consequently there will be no Distinction of Hardness and Fluidity.

§. 6. However that is, this will be own'd on all sides, that Contact can do nothing without Quiescence, and how bare Quiescence should signify any thing to Resistance, no one can comprehend, unless upon this Assertion, That Rest is not only a privation of Motion, but a positive Force in Nature; for otherwise, since the Absence of Motion is only a Negation of it in any Body, there do's not seem to be the least Difference in saying, there is no motion in one Body or another; thus 5 less by 5, or 100 less by 100, are still equal to nothing, and where the Quantity, let it be as different as it will, either of Motion, or any thing else, is destroy'd, the Effect which results from such a Privation, must needs be invariably the same; and by Consequence, if Hardness consisted in such a Quiescence, there would be no Difference in it, contrary to Common Observation; and yet this is the Idea which every one generally has of Rest, *viz.* that a Body is quiescent when it ceases from, or has lost its whole actual Motion.

§. 7. Nor is it at all improbable, but rather certain, that the Philosophers who advanc'd this Doctrine of Hardness, had generally form'd the same Notion of it; for by that means it will be reconcilable with their Hypothesis of a Divisible, Solid, Moveable Matter, and their supposing such Matter put into Motion, and that, upon the several parts of it clashing and interfering with each other, some might possibly lose their Activity, and become

*Quiescence being only a Negation of Motion, there would be no difference in Hardness, since there is none in a Negation of a positive Force,*

*Quiescence being the Negation of a positive Force, can't produce a positive, which Hardness is.*

Quiescent; but then this is only a privation or a mere cessation of Motion, which, as is said in the preceding Section, cannot account for different degrees of Hardness, or indeed for any Resistance, or Hardness at all; for it is no more possible that the taking away, or destroying a positive Quantity or Force should produce a positive Quantity or Force, than it is possible for Nothing to be Something, as is evident from the Addition or Subtraction in the Specious or Literal Arithmethick, in which  $a - a$  will most certainly be equal to Nothing.

*The Foundation of the Question controverted by Philosophers, Whether Rest is positive or not.*

Cartes Princip.  
Par. 2. §. 26. 44.  
Rohault Phys.  
Cap. 10. §. 2.  
Par. 1.  
Dr. Clark's  
Annot.

§. 8. Tho' this therefore was the primary Notion which these Philosophers of Similar Matter had entertain'd concerning Rest, yet afterwards finding it incompetent to answer the Solution of Hardness, which implies Resistance, they joyn'd to their Notion of Rest, as it lay in their first Hypothesis, another Quality of Resistance, and by giving it the same Name, would persuade us they have not alter'd or enlarg'd the thing; and from this Confusion of two different Ideas, under the same Appellation, is deriv'd that Dispute amongst them, Whether Rest is a positive Force, or a privation of one only.

Which Question is easily resolv'd, by distinguishing the Term, which has been render'd ambiguous from the Hypothesis of Homogeneous Matter, into the different Ideas of which it is compounded; for when a Body is said to be at Rest, there are two things considerable in it, its Resistance to Motion or Impulse, and its being actually without Motion; every one must acknowledge the Existence of these two Qualities in a Quiescent Body, and the whole Enquiry that remains is only, which of these two is to be call'd Rest; from which it appears, that this is no other than a trifling Contest about Words, and naming of things, which is in a great measure Arbitrary, and not about things themselves; yet since some Names are in the Idiom of a Language more proper than others to express our Thoughts, let us now examine into that.

§. 9. To

§. 9. To decide therefore this Nominal Controversy, it is manifest, a Body, which has not Motion, cannot be said to be in Motion, and therefore may truly be affirm'd to be at Rest, upon the account that it is not in Motion; but on the other hand, a Body which has Resistance may be said to be in Motion, and therefore upon that Account cannot, in the Propriety of Speech, be said to be at Rest; since then Motion and Rest are oppos'd, according to every ones Opinion of Both, and a Negation of Motion is oppos'd to Motion, when Resistance is not, but may exist in a Body that is mov'd, it is evident, that a Non-Motion may be more properly term'd Rest, than a Resistance to Motion can.

§. 10. If it is still urg'd, that we have not yet reach'd the Depth of the Question, it must be for this reason, because we have taken it for granted, that a Privation of Motion is different from a Resistance to it, whereas they are Reciprocal Terms; But it is evident from what has been said before in Sect. 6, 7, 8, 9. that they are not Reciprocal Terms in the foremention'd Sense of Privation, or Negation of Motion, and if any other Sense is affix'd to Rest, as that it is a Resistance to moving, or, which is the same, an Innate Force by which it is Negative of Motion, and so far Positive of Not-moving, or of Rest, all this is only another Name for Resistance; to prove Rest therefore Positive this way, is to prove precariously, *viz.* because Resistance is Positive; and Rest, or a Negation of Motion is Resistance, because it is defin'd to be so; On the other hand, we have Evidenc'd, that there is a Negation of Motion, under which is comprehended a very different Idea from that of Resistance to it, and which may, with a greater propriety of Language, be call'd Rest.

§. 11. But albeit we should grant to Philosophers their Liberty of attributing the Name of Rest, or Quiescence in either of the afore-



*mention'd Senses, can't account for Hardness.*

Rest, either to Resistance or a Not-moving in Body, yet, neither of these would serve their Turn to the explaining what Hardness is; the last could not for the Reasons alledg'd, nor yet the first, because, it is not included in any of their Principles of Similar Matter, and therefore equally to be accounted for with Hardness, for which it Accounts; for if it is comprehended in Solidity, Hardness will be, as Solidity is, every where the same, contrary to the Notion of it; besides, as it was said before, if it be so, there will be no necessity, upon a Concession of Solidity, to give a Reason for Hardness, which will be only the same Phænomenon under a different Denomination.

*Resistance to Motion has a double Sense, neither of which can explain Hardness.*

§. 12. Moreover Resistance to Motion cannot serve us with a sufficient Explanation of Hardness, since that likewise is a doubtful Term; for it either signifies that Opposition which is made by the Internal Parts of Body to their being mov'd or divided, or by the whole Mass to its being mov'd, or transferr'd from one place to another; which forces are very different, there being a greater Force requisite, for instance, to separate the parts of a Diamond, than to change the Situation of the whole, to penetrate into a Marble, than to remove a Globe of it of several Inches Diameter; if therefore the last is meant by Resistance, it is evident it cannot give an Account of Hardness, because the Force necessary to the moving these Hard Bodies is not adequate and proportional to the Force which is requisite to the dividing of them; If the first, it likewise cannot, because that is not proportional to the Force of Quiescence in the present Hypothesis, which is a general undistinguish'd Term, whereas the Resistance to a Division is peculiar and distinct to each Body, and varies infinitely, whilst the other is the same; Besides Resistance to a Division of the Parts of Body, is the Notion we have of Hardness, and consequently, the Hardness of



of Parts cannot be rationally explain'd by it self.

Lastly, such a Notion of Resistance do's also include Fluidity, which is only a less Resistance of Parts to their being divided, and is upon that Account still more incapable of letting us into the Knowledge of what we mean by Hardness, which is, in this Philosophy, perfectly distinguish'd, and of a different Nature from Fluidity; and yet, according to this Hypothesis, would be explicated upon the same Individual Principle of Resistance, which, in Hardness and Fluidity, differs only in its Degrees.

§. 13. And as Hardness is resolv'd into the Quiescence and mutual Contact of the Parts of Body, so Fluidity is, into the Separation and Motion of them. But as Contact without Quiescence can signify nothing to the explaining of Hardness, so a Separation of Parts, without the Motion of them, it is thought can be of no Service to prove Fluidity, or how an easy Separation of Parts may be made. The Motion therefore of Fluids is first to be prov'd, and next, that, if their Motion was granted, it would contribute to the easy Division of their Parts. As to their Motion, the chief Arguments for it are, First, That if Fluids were not confin'd and circumscrib'd within the Sides of a Vessel, we should presently perceive they could not set limits to their own Action, which would exert it self upon the first removal of the Obstacle, that kept the Motion of their Parts within stated Bounds. Second, That Dissolutions are made of several Bodies, by the continual Agitation and Concussion of the Parts of them, as of Salt in Water, Gold in Aqua Regalis, and Silver in Spirit of Nitre, and so of other Substances in their several Menstruums.

*Fluidity not to be accounted for by the Separation or Motion of the Parts of Body.*

Cartes Prin.  
cip. Part 2.  
§. 56. &c.  
Rohault. Phys.  
Cap. 22. §. 10.  
&c. Par. 1.

§. 14. As to the first Argument it is evident, that from thence there can be no proof had of an Internal Motion of the parts of a Fluid; for let us take

*No Motion prov'd in the parts of a Fluid, from its*

*moving, when  
the Restraint  
of the Vessel is  
taken off which  
contains it.*

take any Elastick or Heavy Body, and suppose the one to be bent by some incumbent Pressure, and the other to be kept from descending by the Intervention of a Solid resisting Substance; no one, I presume, in either of these Cases, will think fit to affirm, that the Elastick, or the Heavy Body actually moves, because, if that restraint, which lies upon them, and curbs their Motion, were taken off, they would move; it is most certain and plain, that a Conatus or endeavour to move, is not actual Motion, unless a Body can be said to move, upon the very Account that it is hindred and restrain'd from moving, which is the Case of the present Argument.

*Not from the  
Dissolutions of  
Bodies im-  
mers'd in them.*

Arg. I.

§. 15. Nor is the second alledg'd of greater Force, before it is evidenc'd that a Fluid lies under the same Circumstances, and obtains the same Conditions, when Salt or any other Dissolvable Body is infus'd into it, and when it exists Simple and Homogeneous, without any foreign Mixture; for Nothing is more obvious than (when two Substances, which are not distinguishable from one another, are put together, as suppose Water to be mixt with Water) that no Dissolution ensues, but each Parcel of the Fluid preserves its own Temper and Constitution, nor is the least Alteration apparent in it; If we likewise throw any other Body into a Fluid, which is not capable of Dissolving it, as Lead, or Glass, into Water; in such a Case, it is also evident, that as there is no Dissolution of the Substance immers'd, so neither do we find any change, or any cause to suspect the minutest Motion in the Liquid, excepting what proceeds from the Force of the Body, which is impress'd, and therefore not Natural to it.

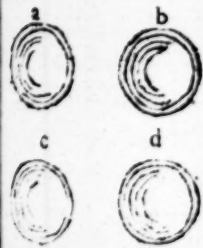
Therefore, since Water's dissolving Salt, for Instance, is made use of as an Argument that it moves; its not dissolving Glass, or Lead, or its own Parts, by a parity of Reason, is a Proof, that it do's

not

not move, and consequently, either this kind of arguing is inconclusive, or if it is good, it proves that Water do's, and do's not move, according to the different Bodies infus'd into it, and therefore that Motion is Extraneous to it.

§. 16. But that this is not a just way of concluding will be farther plain from this, that in all Dissolutions there is a new Colour or Appearance to the Eye induc'd upon the Dissolvent, in most Dissolutions an Effervescence is caus'd, and in some a sensible Ebullition, all which may as rationally be affirm'd to exist originally in the Fluid which Dissolves, as that Motion is in the Dissolvent, precedent to its Mixture with the Bodies it macerates; thus Galls and Vitriol, dissolv'd in Water, produce a black Colour, and Quicklime, a violent Effervescence; and yet, no one ever suppos'd or imagin'd, that clear Water was black, or that cold Water was really hot; if therefore these Properties arise from the Mixture of two different Bodies, how will any one demonstrate that the languid Motion, which Dissolves Salts or Metalls, do's not? Especially, since Ebullition is a sort of Motion, and which is in Fact acknowledg'd to be deriv'd from a like Mixture.

§. 17. Lastly, if we grant Motion to the Internal-Parts of a Fluid; we notwithstanding shall prove, that such a Supposition could not account for the Nature of Fluidity, which consists in an easy and ready Separation of the Parts, upon applying the least Force in order to divide them; from whence, according to this Doctrine, it follows, that all other Things being equal, the Parts of a Fluid are sooner disunited, when in Motion, than when they are Quiescent, which is impossible; for let us imagine *a, b, c, d,*



to be the small parts of a Fluid, moving one amongst

*Not from the Dissolutions of Bodies immersed in them.*

Arg. 2.

*If Motion were allow'd to Fluids, it would be incompetent to solve the present Phenomenon.*



amongst another, and in themselves to be wholly of a passive Nature; either (it is evident) they must move towards each other equably, or they must move from each other equably, or some parts must move towards each other, and other Parts from each other, without any kind of Order or Regularity.

If the first is affirm'd, there will be more difficulty in Separating *a* and *b*, and so of the Rest, whilst they are carry'd with some force towards each other, than when they are endu'd with no Force or Activity at all, by the same reason, that any Action or Force is greater than none; If the second is asserted, since the Parts equably retire from each other, they separate of themselves, and consequently are not capable of being separated, which is the very Notion of Fluidity; If the last is defended, which in all likelihood is meant, the Fluid will not, as is suppos'd, be Homogeneous, but one part of it will obtain a greater Resistance, and another a less; from whence it seems plain, that no Motion of the Parts of Similar Matter can possibly account for this Phænomenon upon any Concession whatsoever; Moreover, how there should be an *Æquilibrium* in Fluids, which is confirm'd by a Multitude of Experiments, when there is a constant Preponderancy of the Moments of the Parts one amongst another, will not easily be explain'd.

**Bohault. Cap.**  
22. §. 12, 13.  
**Par. 1.**

We may farther upon this Section observe, that the Original Properties of Hardness and Fluidity are not derivable from this Hypothesis, but the contrary, that is, a hard Body's being divided with Difficulty, and a Fluid with Ease; for Motion, in the parts of a Fluid, would resist more than Quiescence or Non-Resistance, as Action more than Non-Action; and consequently it would follow, that a Fluid Body should be difficult to be divided, and a Solid easy, since the one consists in the Mo-

tion



tion of its Parts, and the other in Quiescence or a Privation of Motion.

§. 18. The Truth is, That which appears to have led Philosophers into this Error is, that, because the Division of the Parts of Matter is perfectly necessary to their Motion, they have therefore unawares presum'd, that Motion is likewise necessary to their Division; whereas their Motion do's suppose them already divided, and therefore cannot give us a Solution for their Capacity of being divided.

*The Reason why Philosophers might probably enter into this Opinion of Motion being necessary to Fluidity.*

'Tis not yet to be disown'd, that in Hard and Consistent Bodies, as Mettals, Heat is some way or other contributing to their Fusion, and by consequence to their Fluidity; but this is only Accidental, as may be easily concluded, since Quick-silver, and several other Bodies are Fluid, which yet are so far from owing their Fluidity to any sensible Heat, that they seem to possess a quite contrary Quality; besides, if Heat were necessary to Fluidity, it is not from thence manifest that Motion is, till Heat is evidenc'd to consist in Motion solely, which we shall prove it do's not.

*Heat not necessary to Fluidity, or if it was, Motion is not.*

There are two Experiments by which it is thought the internal Motion of the Parts of a Fluid is necessarily prov'd; as powder'd Alabaster by the Force of Fire, and Sand by a violent Agitation on a Millstone, or a Drum Head when beaten, put on so far the Properties of a Liquid Substance, that Bodies which are heavier than it sink, and Bodies which are lighter rise in it, it Curls into Waves, and if a passage is made through the sides of the Vessel, it spouts out like Water; But all this comes to the same, as Fire fusing Mettals; for supposing Motion, in the present Circumstance, should contribute to Fluidity, it is no more a reason that it is Essential to it, than that Heat is; Metals can't be reduc'd to a burning Fluid, that is, hard and compact Bodies cannot without Heat,

*Mr. Boyle's History of Fluidity. Dr. Hook's Micrographia pag. 12.*

Heat, nor Sand without Motion; it do's not therefore follow, that Bodies, which are not Hard and Compact, and which are not Sand, cannot; unless all Bodies were originally Hard, which there is no more Reason to affirm, nor perhaps so much, as that they were all, in their first Constitution, Fluid; Motion and Heat is necessary to take off an Obstacle to Bodies being Fluid, but it is not from thence necessary in Bodies, where no such Impediment was ever prov'd or appear'd to be induc'd.

*The Cause assign'd of Motion in Fluids imaginary, because the Effect is so.*  
Rohault Cap. 22. §. 27. Par. 1.

*That a Fluid Body should consist of Unfluid Parts, not easily imagin'd.*

*The Reason of Dissolutions according to this Philosophy.*  
Rohault Cap. 22. §. 15, 16, 17, &c. Par. 1. Lemmery's Chymistry.

§. 19. Lastly, it is no wonder, that where this Motion in Fluids is altogether imaginary, so Chimerical a Cause should be assign'd to it, as that of a Fluid's Swimming in the subtle Matter of the first and second Elements, which constantly agitate and provoke it, without the least Proof of any such Matter being there, or being endu'd with such a stimulating Quality.

To conclude this Argument of Fluidity, if Motion were allow'd to the internal Parts of a Fluid, and that it was capable of making Bodies more easily divided by any External Force impress'd, such a Solution notwithstanding would depend upon a very inconceivable Notion, that the ultimate Parts of a Fluid are Hard and Inflexible, when the whole is not so; since we have formerly shewn, that an Infinite Division of the parts of a Body cannot any ways change the Nature or Temper of them, Chap. 7. §. 5. Chap. 5. §. 23.

§. 20. Under this Head of Hardness and Fluidity, we may justly rank those surprizing Phenomenons, observable in Nature, of Dissolutions in general and Coagulations; As to what respects Dissolutions, the Force of a Dissolvent is attributed to the Motion of the parts of a Fluid, but since we have already prov'd, there is no such Motion, it likewise follows, that the Power in Liquors, of Dissolving, do's not arise from a Cause which is not in Being.

Besides,

Besides, different Fluids have different Capacities of dissolving Bodies; thus Spirit of Nitre dissolves Silver, and with an Addition of Sal-Ammoniack, Gold, but not otherwise; the Reason of which has been generally ascrib'd to the Grossness of Parts in Aqua Regalis, which cannot penetrate into the small Pores of Silver, whereas those of Gold are larger, and therefore capable of giving an Admission to them; on the other hand, the Parts of Aqua Fortis are so minute and refin'd, that they easily insinuate themselves into the Vacuities of Silver, and consequently into those of Gold too, but without any Effect, because the Solid Parts of it are too great to be mov'd by the Insults of the subtle and delicate Salts it contains.

§. 21. But how lame and imperfect this Account is, is apparent from hence, that it supposes both the Solid and Fluid to consist of hard and inflexible Parts, which, as we have already said, seems to be without any Foundation in Reason; since, besides what has been offer'd on that Subject, we may as justly affirm, that a hard Body is made up of Unresisting Parts, as that a Fluid is of Resisting; and indeed in general it appears to be a truer Way, to ascertain the Nature of the Parts of differing Bodies from the whole, and to make the one Homogeneous with the other, than to determine the several Constitutions of the whole from a similitude, or likeness of Parts, and thereby making them Heterogeneous to it.

*The Parts of Bodies ought to be Homogeneous to their wholes, where-as the reason alledg'd of Dissolutions, supposes them Heterogeneous to them.*

§. 22. If this general Maxim will not be allow'd, in the present Case, however we have a Demonstration of the Absurdity of this Reasoning; for the Velocities of the Parts of these two Dissolvents, Aqua Regalis and Aqua Fortis, are the same, or not: If not, there will be a new Hypothesis requisite to explain the Reason of the Difference, and that which is, at present, assum'd of the dissimilar Grossness of the particular Fluids, will be unnecessary and useless,

*If this Reason of Dissolving Bodies is true in their proper Menstruums, Aqua Regalis will be to Spirit of Nitre, in their Specific Gravities, as 18 to 10.*



less, in respect of moving the Parts of the Body to be dissolv'd; since, if the Velocities are different, the smaller and finer Parts of a Fluid may have as great a Force and Moment as any that shall be conceiv'd to be larger, if the Velocities of the parts of the one are in a Reciprocal Proportion to the Bulks of the parts of the other.

If the Velocities are the same in both, their Force is to be measur'd by the Magnitude of the Parts in each Fluid; let us therefore take a piece of Gold, and one of Silver, of equal bigness, their Specifick Gravities to one another will be nearly, as 18 or 19, to 10 or 11; and since the Matter in both is Homogeneous, each Parcel of Matter in Gold will be to each Parcel of it in Silver, as 18 to 10; if therefore the Velocity is  $a$ , with which one part of Aqua Fortis is endu'd, and by which it is render'd capable of moving one part of Silver, the whole Moment will be  $10a$ , and the whole Moment of one part of Aqua Regalis  $18a$ , if the Gold and Silver are placed at the Bottom of the Viol, by which means the parts of the Menstruum will act downwards; in such a Case, their Specifick Gravities compar'd together, will be in the same Proportion with that of Silver and Gold, that is, the Weight of Aqua Regalis will be to that of Spirit of Nitre or Aqua Fortis, as 18 to 10, contrary to Fact and Experiment. It will be superfluous to mention with what ease, and at the same time, with what little reason, the parts of Spirit of Nitre are affirm'd to enter both the Pores of Gold and Silver, and yet are not equal to dissolve both; for if they can enter, since the Pores, and the intruding Particles, are only consider'd in this Solution, there can be no reason given, (unless upon another Hypothesis of Resistance in the parts of Gold, which may be greater than that in the parts of Silver) why Gold should not be capable of being dissolv'd, as well as Silver; but Resistance is not explain'd



plain'd in this Philosophy, and therefore the Solution from it must be in proportion Defective.

§. 23. Coagulations we may reckon to be of *Coagulations of three Sorts,* either those which are properly so *three Sorts,* call'd, as that Consistency, which arises from a *none of which are accounted for in the present Philosophy.* mixture of an Oleous Spirit with an Urinous, as *for in the present Philosophy.* Spirit of Wine or Oil of Vitriol with Spirit of *Sal-Ammoniack,* or of Urine; or else, those which the Chymists Name Precipitations, as when any *Rohault Phys. Cap. 22. §. 22; 24, 25. Par. 1.* thing is dissolv'd by an Acid, the Infusion of an Alkali, or even Salt, makes it subside to the Bottom, which by an Acid will be rais'd again to a transparent Fluid; Or lastly, those which are distinguished from the rest, by striking out into variously figur'd Chrystals: None of which are accounted for, upon the Hypothesis of Similar and Homogeneous Matter.

*Lemmery's Chymistry. Mr. Boyle.*

§. 24. As to Coagulations, the chief Reason which *The Reason assign'd of Coagulations not valid.* is given of them is, that the Parts of each Fluid are of that particular Figure and Magnitude, that the more they move the more they are entangled, and by embarrassing one another, at Length, become a consistent Body; but how Fluids, which in Dissolutions are suppos'd to have sharp and pointed Parts, in Coagulations should change them into little ramous and hooked Ones, or Acids continuing the same, how Alkali's should have Pores exactly fit for them, can be no other way solv'd than upon that happy Freedom, which the Philosophers of a Brutish and Passive Matter enjoy, and very liberally make use of, of shaping it into those Figures, and contriving those Properties for it, which are serviceable to their present Occasions: And indeed it was with good Reason, that they invented such a kind of ductile and easy Nature, which might be always ready to pay a blind Obedience to their Fancies, and over which they might exercise an absolute and unlimited Dominion. I know it is farther said, that the Parts may likewise

*Rohault Cap. 22. §. 25. Par. 1. Lemmery's Chymistry. Mr. Boyle.*

wise be so adapted to each other, as by their mutual Contact to become Quiescent, but this Doctrine we have before consider'd.

*Three Accounts given of the Reason of Precipitation.*

Robault Cap.

22. §. 24. Par. 1.

Mr. Boyl's

Sceptical Chymist.

§. 25, The next Phænomenon to be explain'd is that of Precipitation, which this Philosophy of Homogeneous Matter is equally incapable of solving, with the others already mention'd; for it is acknowledged by it, that a Body which is dissolv'd Precipitates, either by the parts of the Dissolvent being more fitted to the Salt or Alkali which is infus'd, upon which account it quits the Body it has already dissolv'd, and embraces the other; or by adding a Weight to the Body which is dissolv'd; or lastly, by diminishing the Force of the Dissolvent.

*The Aptitude of the Parts of the Dissolvent to those of one Body, in preference to those of another, not a sufficient Explication.*

§. 26. The Aptitude or Correspondency of the Parts of the Dissolvent to one Body, which it dissolves, in Preference to another, is not sufficient to explicate the present Difficulty; because those small Atoms which render it capable of putting the heavier Parts of a Substance, which is strong and compact, into Motion, as Silver, will not therefore desert those more obstinate Particles for lighter and more yielding, as Salt, unless upon some new Principle introduc'd into Nature, besides mere Similar Matter differently figur'd, and Motion; for if there is a certain Degree of Motion, for Example, in Spirit of Nitre, and a certain and determin'd Figure in the Parts of it, seeing this definite Figure and Motion can dissolve Silver, there is no more reason it should relinquish it, upon the account of Dissolving Salt more easily, than that Matter with any Force or Velocity given, of two Bodies, against which it is carry'd by a blind Impulse, should have the Liberty and Choice of Spending its whole Moment upon the weaker, and Voluntarily, of itself, and without any other impellent Cause, should divert and turn aside from the more resisting, tho' capable of being mov'd by it.

§. 27. Ano-

§. 27. Another way that Precipitation is said to be perform'd, is, by loading the Parts of the Body dissolv'd, by a new Accession of Matter, from whence they come to preponderate and subside; but it will be hard to say, since the parts of a Fluid are in an *Æquilibrium*, how, or for what Reason, the Body dissolv'd should sink rather than the Dissolvent, for where the Forces of both are in an equal Poise, no Cause can be assign'd why the Parts of the Body dissolv'd should fall, and those of the Dissolvent emerge above them, which will not be as good to prove the Contrary.

If it be affirm'd, that there is an Action in the Dissolvent, which keeps up the dead Weight of Silver, an Addition to which Weight must necessarily make it superior to the Action, if they were equally balanc'd before; or, as the third Argument alleges, which comes to the same, and which we shall therefore jointly consider, with this present, if it be affirm'd, that a Weight added to the Action of the Dissolvent will diminish its Force, and by that means likewise increase the Comparative Gravitation of the Body dissolv'd, neither of these, in the Philosophy of Homogeneous Matter, are true; for the Moment of Silver, for Instance, dissolv'd, being equal to the Moment of the Dissolvent, which Moments are computed from the Matter and Motion of each, so that so much Motion is answerable, and produces the same Effect on one hand, as a like Quantity of Matter on the other, and reciprocally, by forming an *Æquilibrium* betwixt both it necessarily follows, that if there is an Addition of Matter on either Side, that Side must preponderate on which it falls; from whence it will ensue, that either the Dissolvent may precipitate as well as the Body, which is dissolv'd, or, that neither of them will, which seems to be most reasonable to think, if this Hypothesis were Valid, both which Conclusions destroy the Phenomenon.



*ChrySTALLIZA-  
tion not ac-  
counted for by  
this Philosophy.*

*Lemmery's  
Chymistry.*

§. 28. The third Sort of Coagulum is, what Chymistry names ChrySTALLIZATION, which proceeds from a Salt dissolv'd in Water, or Mettals, in Aqua Fortis, or Spirit of Nitre; evaporate the Dissolution, till there is a small Film spread over it, and when it is set to Cool, it will shoot into ChrySTALS; The first Account that is given of this Extraordinary Appearance is, that after a Menstruum has dissolv'd as much as it can, by the Access of Heat, when that fails, some parts of the Body, which is dissolv'd, must fall, and gather into different Figures; But this seems to be extremely deficient, and a Cause is invented altogether unequal to the Effect; for by the Mixture of the Dissolvent, the Heat which makes one part of the Dissolvent, and the Body dissolv'd, there is one Fluid produc'd of an equable Motion on all hands; such an equable Motion therefore, as it gradually decay'd, would not throw the parts of the Body dissolv'd into several distinct ChrySTALS, but as the former languish'd, the other would only fall in proportion, and instead of ChrySTALLIZING, would be found to precipitate in a flat Powder, granting to this Philosophy even the Notion it has form'd of Precipitation from the Languishing of the Dissolvent.

If this yet were certain, which is not prov'd, there would no more of the Body, dissolv'd by Heat, fall, by the decay of it, than what the Menstruum could not originally without Heat, not only support, but raise by Dissolution; for how *that* Silver, for Example, should subside into Vitriol, or ChrySTALS of the Moon, by the decay of Heat, the Force of *which* was surmounted by that of the Spirit of Nitre without it, *i. e.* how that should subside and sink in Spirit of Nitre, which was rais'd and dissolv'd by it, where there is only the Gravity of Silver and the Action of the Spirit of Nitre consider'd, will be a Mystery not to be unravell'd.



As for a second Account, that there are latent and pointed parts in the Salts which are dissolv'd, which is evident from their Shooting out into Needles, that is giving a Reason for the Effect, from the Effect; for the Question is not, whether there are Points or Chrystals, but how they are made, and to say, that they come to be Chrystals and pointed Figures, because their parts are so, is no more than to affirm they are Chrystals, because they are; unless a Fluid may not be thrown or darted into Points by an Action, when the Fluid is not originally so, as Water, which is not suppos'd to have pointed Parts, yet, if thrown upon a Table, by the Action communicated to it, may acquire those Qualities in respect of Figure, which it had not before.

## CHAP. IX.

*Concerning the Account given by the Corpuscular System, or that of Homogeneous Matter, of other the Accidental Properties of it.*

§. 1. **N**EXT to Hardness, and Softness, or Fluidity, it will not be improper to enquire into Rarefaction and Condensation, which some ancient Philosophers have resolv'd into the Qualities treated of in the preceding Chapter; for when they possibly apprehended, that different Portions of Matter might be extended, and as it were drawn out into the same Space, they concluded, where there was more Matter, there must be a greater Density, and by consequence a greater Degree of Resistance, and where there was a less Quantity of Matter, that Resistance would be proportionably diminish'd, and would therefore put on a Form, that was more Fluid and Yielding. Which

*The Account given by Aristotle of Rarefaction and Condensation, not valid.*

Cartes Prin-  
cip. Par. 2. §. 6.  
Rohault. Cap.  
8. §. 5, 6.  
Par. 1.

Notion, altho' it appears to be sufficiently confuted from the Nature of Ice, which is lighter, and yet harder, than Water, that is, if we allow the Gravity of a Body to be proportional to its Matter; We cannot, however, but say on the other hand, that those who reject this Explanation, do not seem to give a better, from supposing Matter to be Similar and Homogeneous, and referring the Solution to an Ingress of certain subtle Parts of it in Rarefaction, and in Condensation to an Expulsion and Exclusion of 'em.

*The Modern  
Account of  
Rarefaction  
and Condensa-  
tion equally  
invalid with  
the former.*

Arg. 1.

§. 2. For if Matter is alike, as we have already shewn this Philosophy supposes, the subtilizing of its Parts can be of no service to the refining of its Substance; which will, notwithstanding all we can do in that way, retain the same individual Nature, and will, in all the minutest Parcels of it, be equally Gross and Dense; and therefore, for the Pores of a Body to be fill'd with such a subtiliz'd Matter, is in Effect the Condensation of it, *i. e.* Rarefaction is endeavour'd to be explicated, by that which would in reality condense it, namely, an addition of the same Matter in the same Space.

*The Modern  
Account of  
Rarefaction  
and Condensa-  
tion invalid.*

Arg. 2.

§. 3. But what is more, Rarefaction and Condensation, as they are Appearances in Nature, imply something farther than this Hypothesis accounts for; since, if the most is granted to this kind of Reasoning, it only defines what a rarefy'd Body, or a condens'd is; namely, that the one consists of a subtle Matter intermix'd with a Grosser, and the other of a Substance which is entire and uninterrupted by any Matter Extraneous to its own; whereas the Intrinick Action of Rarefying and Condensing, by which any Body is rarefy'd or condens'd, is not in the least consider'd, which yet enters into the very being of these two Phænomenons; for tho' by the Intrusion of subtle Matter a Body should be rarefy'd, and by the Expulsion of it condens'd, yet whilst there

there is no cause assign'd, how, and by what means, this Intrusion and Expulsion is perform'd, whilst it lies in the Will and Pleasure of the Philosophers only to command this Matter in and out, as they think fit, the Action in Nature, by which Rarefaction and Condensation is produc'd, is still unknown, or at least unexplain'd by 'em.

§. 4. Resiliency, according to the Corpuscular *Resiliency of* Philosophy, owing likewise its Force to the Efforts of this Subtile Matter, will naturally fall under an Examination here, which is said to consist in the Minuteness of the Pores of the recoiling Body; that is, upon the Bending, for Instance, a Plate, or Lamina of Steel, the small Meatus's are contracted on the Concave part, and enlarg'd on the Convex; the Subtile Matter therefore insinuating it self on the Convex side, and endeavouring to make its passage through the Pores, which are streightn'd, whilst it presses forward to open an egress to it self, it at the same time restores the Lamina from its Constriction.

§. 5. Against which Explanation there are Three Arguments; First, that these Pores, which are suppos'd to be of a Conical figure, are entirely fill'd with the Subtile Matter, and consequently, if that which is at the Top, or Apex of the Cone, has a power to act upon the Body, which resists, that which possesses the parts toward the Basis of it, will have *à fortiori* a Power to resist the Body, which acts by its Renitency; and therefore it will be necessary for the Plate to continue bent contrary to the Phænomenon, since the subtile Matter cannot act more on the concave part of the Steel, than it will resist on the Convex to a restitution of it: And this is still more evident, if we consider the true Nature of this subtile Matter; which however small it is presum'd, in respect of its Parts, is in reality the same with the grossest Matter, and therefore no more capable of

*Bodies how explain'd by the Moderns.*  
Rohault Phys.  
Cap. 12. §. 36.  
37. Par. 1.

*Three Arguments against this Explanation.*  
Arg. 1.



Arg. 2.

Arg. 3.

producing such an Appearance, than if so many little Wedges were struck into these imaginary Pores, being first adapted to the Cavities of them, which instead of causing a Resiliency in the Steel, would fix it in its bent position. Secondly, If the subtile Matter presses only one way, there will be a Force of Resiliency one way only, contrary to Experience; if every way, there can be no egress of the subtile Matter on the Concave side, or retiring on the Convex of the Lamina, because the subtile Matter without, presses with an equal Force against that within. The Third Objection against this Account, is, that it will not satisfy for other Appearances of the like Nature, as the Renitency of the Air and of Fluids, whereas it is an undoubted Maxim in Philosophy, that of Parallel and Similar Effects, the same Causes ought to be assign'd as of Fluidity, whether in Water or Air; of Transparency, whether in Glass or in Æther, &c.

*The Solution of Resiliency from Action and Reaction, in the Parts of Resilient Bodies, not just.*

Rohault Par. 1. Cap. 22. §. 37. Dr. Clark's Annot. Edit. 2 & 3.

*An Examination into the Modern Doctrine of Heat.*

§. 6. As for any other Solution from the Equality of Action or Reaction in Bodies, that likewise cannot be sufficient; since the Pressure and Repressure of the Parts being always the same, when they are once reduc'd to a certain posture and inclination amongst themselves, a Body being continually bent, would never lose its Force of Resiliency, which it certainly do's, and for the same Reason the Attraction of the Parts can signify nothing to the solving the present Phenomenon. These Notions however might be otherways confuted, but not falling in with those Solutions, which more immediately depend upon the Supposition of a Similar and Homogeneous Matter, we shall at present leave them, and proceed to consider the Explications given us of Heat and Cold, after those of Rarefaction and Condensation, and of Resiliency.

§. 7. Heat has generally been conceiv'd by the Modern Philosophers, to depend upon the Agitation of the parts of a Body, which are suppos'd



to put on an irregular and anfractuons Motion, and to revolve about their own Centres: This is prov'd from our Breathing hot and cold, the first being done by a Circular Tumultuary Motion of the Air, expell'd from the Lungs, and the last by a direct and rectilinear; from rubbing our Hands together when we are a-cold; from several mixtures of Liquors, which produce a very sensible effervescence, as Oyl of Vitriol with Oyl of Tartar; and from the Axle-tree being fir'd by the Motion of the Wheel upon it.

§. 8. It will scarcely be necessary to confute such Instances, which are all of 'em precarious; for by what Laws of Mechanicks do's the Revolution of the Wheel impress a circular or confus'd Motion of the parts in the Axle-tree? If it do's, how do's the Reciprocation of a File upon Iron, or the stroke of a Hammer upon a Nail, which are very different Impressions, produce the same Motion, which is thought to be the Cause of Heat? If therefore it is plain from this, that different Directions of Motion, exhibit the same Effect of Heat, why should we conclude that Heat may not be produc'd from our Breath, or from the Mixture of one Oyl with another, without its ascertaining a Motion, which is not essential to it, but vary'd in different Circumstances?

§. 9. But if we shew, that an actual Motion of Parts amongst one another is not requisite to cause Heat, any particular one will be much less so. No one ever yet dream'd, that there was an actual Motion in the Parts of those Bodies which furnish us with the Sensations of Feeling, or even the stronger ones of Pain, it is easy to have a very violent Perception of it, from the Point of a Needle, when at rest, by the bare Application of the Finger to it, or from a Flat and Quiescent Body, as the surface of Wood or Stone, when the Skin is taken off from the Fibrillæ of Sense; why therefore Mo-

Robault Cap.  
23. §. 10. Par. I.

*Argument 1st.  
against this Do-  
ctrine, That a  
Heat do's not  
consist in any  
particular Di-  
rection of Mo-  
tion.*

*Argument 2d.  
that Actual  
Motion is self  
is not necessary  
to Heat.*

tion should be necessary to our Perception of Heat, any more than it is to our common and ordinary Sensations of Feeling, or the more tender and active of Pain, cannot be demonstratively concluded; for supposing even in the Corpuscular way, that Flame, which is the most Agile and Volatile of all Bodies which produce Heat in us, consisted of small pointed parts, they would equally cause a Sensation of Pain in us, as if they were endu'd with the most intense Motion.

'Tis true, we perceive a Motion in Flame, and in the Ebullition or Effervescence of an Acid and an Alkali, but it is not so evident in an Iron that is heated; therefore if our Senses are to be judges, in the present Case, they will pronounce both for and against actual Motion: Besides, it is manifest Air has a great Influence in causing the Motion of Flame, which when mixt together, seem to represent the Acid and Alkali; *i. e.* there is a Motion produc'd, but this is no more a Proof that Motion is innate to Flame or Heat, or essential to it, than because Oyl of Vitriol in Spirit of Sal Ammoniack or Oyl of Tartar boils up, that therefore Oyl of Vitriol, which has a burning Quality, has an actual Motion, consider'd abstractedly by it self, and separate from all other Mixtures, which we have endeavour'd to evince in our Chapter of Fluidity, is not necessary, or rather is unreasonable to suppose.

*Argument 3d.  
From this Do-  
ctrine of Heat  
not explaining  
how that parti-  
cular Motion is  
produc'd, in  
which Heat is  
suppos'd to con-  
sist.*

§. 10. Were all notwithstanding granted to this Philosophy, which it contends for, not only that Motion is necessary to produce Heat, but a Circular one likewise of the parts which are agitated; it will be still inconceivable, how the Original Notion which it lays down of Similar and Homogeneous Matter, and bare Motion, should account for the Phenomenon of Heat, unless by an Arbitrary Direction of that Motion, to those purposes and intents which it has in view; *e. g.* The Heat which is produc'd upon the Ebullition of an Acid

Acid and an Alkali, depends upon a Circular or Confus'd Motion; but which way is that Confusion, or particular Determination caus'd? There is no Solution given of this, tho' Heat is affirm'd to proceed from it; (And the same may be said of the other Instances alledg'd) for if it be from the Mixture only, why do we not perceive the same Effect from the Mixture of any two different Liquors in general? What is that particular Genius in Oyl of Vitriol and Oyl of Tartar, which causes Heat? not the Difference in the Particles of these Fluids; since it is more apparent to our Senses, that there is a Circular and Confus'd Motion, upon the mixture of any two Liquours, which should therefore all produce Heat, than that there is a Distinction in the Figure of the parts of Fluids, and therefore that only some should produce this Circular Motion.

§. 11. But let this Solution, which at the best is gratuitous, be put upon the different Figures of the parts of a Fluid, some of which are apter to fall into a Circular Motion than others are, how yet could this produce Heat, unless the Force and Moment of the moving parts was augmented by it? which is an Argument in general against a Confus'd, Anfractuouse, or Circular, or any other particular Modification, or Figure, being the Cause of the present Phænomenon.

*Argument 4th.  
from an Impossibility of perceiving Heat, or the various Degrees of it, by a bare Direction in Motion only, without an Increase of its Force.*

The Figure of Motion, whether it is Circular or Direct, cannot alter the determinate Degree of Motion, but the Impressions of External Agents upon us seem to be proportional to the Intensity or Remissness of the Action, rather than to the Figure it describes; and therefore, as our Sensation of Heat is more violent than that of Warmth or Coolness, so we may rationally conclude it is produc'd in us, by a more vigorous and intense Force; but how Motion is increas'd by becoming Circular, will be difficult to explain; or how two Bodies,



Bodies, which have a less Motion separately as an Acid and Alkali, should, when mix'd together, produce a greater; except we lay down some other Principles than what are included in an Homogeneous Matter, and the plain Motion of the parts of it one amongst another.

*Cold not solv'd by this Philosophy, which contrives different Hypotheses for the Solution of it.*

Rohault Cap. 23. §. 49, 50. Par. 1.

§. 12. If the Corpuscular Philosophy gives us an imperfect and unsatisfactory Account of Heat, it has contriv'd still a worse of Cold, in making the same Property, in different Subjects, arise from a variable and inconstant Cause; thus Cold, in hard and consistent Bodies, is attributed to Quiescence; in fanning of the Air, to a Direct Motion, and in Water, when we put our Hands into it, to the more faint and languid Action, which it has in respect of the Blood; this, as we said before, is offending against the Fundamental Rules of Philosophy, viz. to assign several different Causes of the same Effect; for, by the like Imperious and Arbitrary Methods, we may take as many Hypotheses as we please, and by that means leave nothing in Nature without a very exact Solution; so where we find the parts of a Body are at rest, and are cold, it is solv'd by Quiescence; where in Motion and Cold, it is solv'd by Motion, which is suppos'd to have a particular Direction, different from what produces Heat, lest the same Cause should be made to explicate the Opposite Qualities of Heat and Cold.

*Cold not explicated from these Principles of Homogeneous Matter, because it is suppos'd to be a Privation or Extinction of Heat, tho' it has as positive a Force as Heat itself has.*

§. 13, That farther which makes this sort of Reasoning the more inexcusable, is, that all these Hypotheses are form'd upon a wrong Notion, that Cold is only an Exinction of Heat, which is suppos'd to consist in a certain Motion; and therefore whatever stops, diminishes, or retards that Motion, as rest, an opposite Determination of Motion, or a slower Motion than that on which Heat depends, is imagin'd to be the occasion or cause of Cold.

In which Explanation it is originally presum'd, that Heat consists in a particular Motion, which has been already



already refuted; if that should be confess'd, how Cold is prov'd to be only an Exstinction of Heat, or a Stoppage, or Privation, or a Diminution of Motion, will be difficult to apprehend; seeing we evidently find by Experience, that Cold is not an Unactive Principle, since it raises a Weight in the Freezing of Ice, and strikes several Yards into the Earth, with a Force that can never be explicated by a bare Privation or Retarding of Motion; and we may as well affirm, that Heat is an Exstinction of Cold, as that Cold is of Heat, and that both in their turns may be call'd Quiescence, or some Degree of it.

§. 14. Another Objection against this Solution of the Phænomenon of Cold, is, that if Quiescence, or any Relative Degree of it, in respect of a contrary Motion, was sufficient to explain it, as a direct Motion is suppos'd contrary to a Circular, and therefore produces Cold; if (we say) this Doctrine were true, it would follow, that one Circular Motion, being contrary to another, by the same Argument, it ought to produce the Sensation of Cold in us likewise; but a Circular Motion is said in general to produce Heat, and therefore a Circular Motion may produce both the Sensation of Heat and Cold, which is a Contradiction.

For Instance, we perceive our Hands warm, and therefore the Blood has a Circular and Confus'd Motion; but the parts of warm Air or Water are likewise in a Circular and Confus'd Motion, therefore the several parts of the Water, turning round upon their Centers a different way from those of the Blood, will as much, or more, diminish the Motion of the Blood, than direct Motion would; if it is necessary that all the parts in both Fluids should be revolv'd the same way, there will be more requir'd than a Circular Motion, that is, more than is laid down in this Hypothesis.

*The same Account is given of Coldness and Hardness, whereas Bodies which are the hardest, are not always the coldest.*

§. 15. To conclude, If Quiescence, or any relative Degree of it, with respect to a contrary Motion, was necessary to this Solution, the first in hard Bodies, and the last in Fluids; in hard Bodies there would be the same Account of Coldness and Hardness, and consequently the Arguments for a privation of Motion being a positive Rest, would be equally as invalid here, as they were prov'd to be before; And in Fluids, so far as there was a Relative Quiescence, there would likewise be a Relative Hardness, nothing of which is yet sensible, since in the coldest Water, there is no abatement of its Fluidity.

Those Bodies farther, which were equally quiescent (taking Rest in a positive Sense) *i. e.* which equally resisted to a Separation of their parts, would be alike cold, and in proportion, those, which resisted the most, would be the coldest, and consequently a Diamond would be colder than Snow, contrary to Experience; if Quiescence is understood in a privative Sense, then, seeing there would be no Degrees in Rest, which, in one Case or another, would be only a Negation, or Destruction of Motion, or of a positive Force, it would follow, that there could be no Degrees in Cold, but all Bodies, which had that Quality, would possess it without any manner of Distinction.

*Smoothness and Roughness unexplain'd by this Philosophy. Rohault Cap. 23. §. 62. Par. 1.*

§. 16. Smoothness and Roughness are two other Properties in Body, which the Philosophy of Similar and Homogeneous Matter is incapable of solving; yet these, it tells us, are so evidently deduc'd from the different position of the Parts of Corporal Beings, that it has not thought there was any necessity to enlarge upon a particular Explanation of them; whereas it will be found a very difficult province to reconcile different Colours, with the same Roughness or Smoothness, or the same Colours with a different, according to the present Systems; thus *e. g.* if we compare the Smoothness

ness of a piece of white polish'd Marble with that of a Black, we shall not perceive by our Feeling the least **Asperity** in one more than another, and consequently the **Arrangement** and **Disposition** of their parts ought, upon this Hypothesis, to be the same; which, on the other hand, will never agree with the Account of Colours, which makes their Order and Complexion to be extremely opposite, so as one should give a free Ingress to the Rays of Light, by those numerous Pores it forms, and the other, on the contrary, should rise into as many little protuberances, whereby the Rays of Light are shatter'd, and reflected in all imaginable Angles: In like manner, if we take two Bodies of the same Colour, the one rough, and the other smooth, as crude, and beaten or polish'd Gold, the internal and the most intimate Order of the Parts is the same, by reason of the Colour, tho' at that time we are sensible that the Roughness or Smoothness of each Body is not; from whence it is apparent, that these two Phænomenons of Roughness and Smoothness, in the Sense of this Philosophy, do not depend upon the intrinsic Order of the parts of a Body, but upon their accidental or external Asperities, let their internal Constitution be what it will, in respect of the Oeconomy or Disposition of them; and if so, that when two Bodies are equally polish'd from their outward Asperities, or Protuberancies, they should be alike smooth, which is not experienc'd.

§. 17. Since this likewise is farther to be observed, that where there are no perceptible Asperities in Bodies, and where all the parts seem to be equal, there is something which distinguishes the smoothness of one Body from that of another; thus the smoothness of the finest Wood, or of Ivory, is different from that of burnish'd Steel, and that from Marble; the one feels dryer and harsher, and the other more soft and oily; which therefore

*There is something peculiar in Bodies, which to appearance are of an equal Smoothness.*

is



is to be explain'd in conjunction with our Perceptions of Hardness, and Softness, and Fluidity (seeing Fluids are also smooth) which we have already evidenc'd the Corpuscular Philosophy cannot do.

*What Brittleness, and its contrary Quality, is, in the Notion of this Philosophy.*  
 Rohault Cap.  
 22. §. 43. 44.  
 Par. 1.

§. 18. The last Affections of Matter we shall take notice of in this Chapter, are those of Brittleness, and its contrary Quality; Brittleness is affirm'd to consist in Parts, which are united together by a bare contact in single Points; and its contrary Quality, in such as are sheath'd and mingl'd with each other; the former is prov'd by the shortness and evenness that is observ'd in Breaking of a Brittle Body, as Glass, and the latter in there being several Lacinix or small Inequalities apparent, as in the Tearing and Separating of Paper or Leather.

*The Properties brought to explain Brittleness, and its contrary Quality, want to be explain'd themselves.*

§. 19. Against which Account it may be justly allעדg'd, that the Properties introduc'd to explain these two Phænomenons, equally want to be explain'd themselves, even upon the Supposition of the present Philosophy; for, what is the Reason of the one sort of Bodies breaking short in two, and the other into Lacinix? If it be said, because the Parts of the first touch each other in a Point, and the Parts of the last have a lateral Connexion, if we allow the most to this Reasoning, it is no more than to say, Bodies are brittle or limber, because they break short or in small Lacinix, or they break short or in small Lacinix, because they are brittle and limber: The Question therefore lies, why, or how one Body has in its Parts a contact only, and another, a lateral Connexion, and then, supposing both, which way they can resolve the Properties before us?

*All Bodies, according to the Corpuscular System, ought to be Brittle.*

§. 20. As to the First, it seems evident that those who confess an Homogeneous Matter, do presume that it is originally divided into infinitely small Parts, and therefore the Lacinix, that are suppos'd, or the lateral Connexion of these Parts must be



be to our Senses, upon the breaking or dividing of them, no other than a bare contact of them; and consequently there will be no difference in the perceptible Effects betwixt the breaking of a limber Body or a brittle, since, in the last Result, they will be reduc'd, upon breaking, to a bare contact.

As to the Second, Granting they were not, but that there were long and visible Parts, of which a limber Body consisted, there is yet no Solution given how these Parts are joyn'd and cemented together, unless by an uniform Quiescence, which could only produce this appearance, that as a brittle Body made an even Fracture, for Example, in Glass, so a limber one would an uneven, as in Antimony, which breaks into Needles, or certain oblong and pointed Parts: Besides, if this would solve the Difficulty, which way those Parts become limber, how they bend and yield to every Force that is apply'd to 'em? that remains a Problem still, and will want another Hypothesis to solve it. Lastly, that uniform Quiescence, by which these Parts are joyn'd together, is unintelligible in this Philosophy, and has been consider'd in the foregoing Chapter.

Having therefore examin'd into the several Properties of Matter, which are impress'd upon us from our Feeling, the next we shall proceed to, are those of a more tender and delicate Nature, *viz.* those which we receive in, by our Taste, or Smell, or else from our Sight, or Hearing.

## C H A P. X.

*Concerning Tasts and Smells, as accounted for by the Hypothesis of Homogeneous Matter.*

*It is unlikely that a Philosophy, which cannot solve the Grosser Appearances of Nature, should the more refin'd and delicate.*

§. 1. **O**UR Enquiries concerning the Sufficiency of a Similar and Homogeneous Matter, to give us a Rational Solution of the Affections of Nature, have thus far extended to those Properties only, which our Minds are taught from the dull and languid Informations of Feeling; but if such an Hypothesis is defective, in explaining the grossest of our Perceptions, and the most undistinguish'd of any that we have, we cannot expect it will be more faithful to us, in accounting for those Phænomenons, which are of a finer Sense, and strike us more uncertainly, and with greater Variety and Distinction.

*Wherein Tast is suppos'd to consist.*

Rohault Cap. 24. §. 6. Par. 1.

*The Grossness of the Parts of Matter, consider'd as the Density of 'em, cannot contribute any thing towards an Explanation of Tasts.*

§. 2. Of which sort, the first we shall mention, are those our Tast supplies us with, which are resolv'd into the Crassitude or Grossness, or the Figure and Motion of the Parts of Body, none of which are capable of Assigning the Cause of the different Sensations we receive from Tasting.

§. 3. As to what concerns the Grossness or Density of the Parts, if that is meant by Crassitude, that cannot be of any Advantage to the present Solution, in a Philosophy of Similar and Homogeneous Matter, or, which is the same, an Abstracted Idea of it; because, according to the Doctrine it affirms, there can be no Diversity in Extension, Solidity, Impenetrability, Gravity, and the rest; but there is a great deal in our Tasts, and therefore what is Similar and Homogeneous cannot contribute in the least to a due Explication of them.

§. 4. It

§. 4. It is easy to imagine what will be farther urg'd on this Head, that tho' the Grossness of Matter, in the present Philosophy, is uniformly the same, yet the Magnitude of the Parts, into which it is divided, is different, and in that consists the Grossness or Crassitude of them. Let us therefore allow, to the Corpuscular System, the absolute Liberty of contriving into several parcels that Material Composition of Properties, which it has with the like Arbitrary Freedom enjoyn'd us to receive, as a certain and undoubted Definition of Corporeal Being.

*The, different Magnitude of the Parts of Body cannot cause any Essential Difference in our Perceptions.*

Can, notwithstanding this, the different Magnitude of the Parts, assist us in the Solution which is wanting? I am apt to believe it cannot, unless, where the same Motion and Figure is acknowledg'd, a Globe, for Example, of two Inches Diameter, and another of three, can raise differing Sensations in us, which is impossible; all that can be expected from such an Application of two different Globes to our Organs of Perceiving, is only this, there will be an Extension, or an Enlargement of the same Perception, without any Distinction in the Nature of it; since we neither find nor experience any other Idea, than that of Gold or Wood, or what Body else we choose to contemplate, whatever the Dimensions of it are, or which way soever it is apply'd to our Senses. The Impressions upon our Minds are alike, from the same sort of Matter, excepting what Variation they confess in the Magnitude and Figure of several Portions of it.

And the same Reasoning will hold, if we diminish these Parts of Matter to Infinity, and suppose the Sensory small in proportion, that is, to consist in Nerves, or the little Capillary Fibrillæ they send out, and spread over the whole Palate; thus the infinitely small point of a Needle, if it barely touches the Tongue or Finger, will only raise the Sensation in us of its extreme Minuteness, and what Pain is consequent upon it by entering the Sen-

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sory,



sory would equally follow upon the Application of a Globe or a Cube, if the Sensory was made bare, and laid open to receive its Impression.

*Motion, in the Sense of the Corpuscular System, cannot solve the Difference of Tasts.*

§. 5. The next Principle we are to consider, is, that of Motion, which will not explain the Difference of Tasts, so long as it is esteem'd and apprehended to be an Abstracted and a Similar Idea, and, as to the Force of it, invariably the same; 'tis true some Motions are suppos'd to be Direct, and others Circular, and all the Determinations are invented that possibly can be, but still the real Force and Action is unalter'd; If not, a new Supposition is to be introduc'd into the Philosophy of Homogeneous Matter, and consequently the present Hypothesis will be insufficient; If the Action is the same, it can only account for one kind of Tasts, and will never be able to solve the various Phænomenons we have from that Sense.

*The Corpuscular System supposes an Uniform Motion, or Velocity in the Parts of Body.*

§. 6. In the foregoing Section we said, that the Corpuscular Philosophy must either assert a various Force, separate and abstracted from every thing else, in the Motion it self, which it assumes, or else must alledge the same Force, and suppose it to be diversify'd, by reason of its distinct and peculiar Modifications of Figure and Determination, or from the Magnitude and Shape of the Parts which are mov'd; for, if Motion is unchangeably alike, in all the several Corpuscles in Nature, without any various Modifications, it is evident, that different Tasts could not be produc'd from it.

*An Uniform Force, or Velocity, affirm'd by this Philosophy.*

§. 7. It do's not seem to affirm the First, that is, a various Force separate and abstracted from every thing else, because it supposes some Parts to be turn'd round upon their Centres, others to obtain a direct progressive Motion, and in all the Solutions, which it gives, resigns the Business to the Figure which the Motion describes, or the Determination it receives, together with the Shape and Substance of the Particles which are acted; but if there were a peculiar innate Velocity



city or Motion in them, without considering any other Circumstances, by which our Organs of Sensation might be variously and distinctly shock, the Hypothesis of different Sizes and Forms in the Parts, and of particular and certain Determinations in the Motion of them, would be altogether unnecessary and superfluous.

§. 8. Moreover, this Philosophy tells us, that Almighty God impress'd upon the Parts of Matter a certain Motion, and then left them to act amongst themselves, according to the stated Rules and Laws of Impulse, in order to produce the several Effects in Nature; that is, it supposes a Similar Velocity belonging originally to every Portion or Atom of Body thro' the Universe; if not, if one Atom had a distinct Force from another imparted to it, all the Contrivance (we say) of the various Figures and Determinations of Motion, and the Difference in the Magnitude and Circumscription of Parts, that is, the whole Corpuscular Philosophy falls to the Ground; for where a Thousand, or a Million several Forces are arbitrarily impress'd by Almighty God on the same Subject, as Matter, without any thing previous in the Nature of one part of it more than another to cause the Distinction; how are things accounted for by two or three modest Demands only of Matter, Figure and Motion, when the last alone presumes so many Dissimilar Powers already made, and produc'd in Corporeal Being, sufficient of themselves to satisfy all the Phenomenons of it, without any other Assistance from the kind Wit and Inventions of Philosophers.

§. 9. Farther, all other Principles made use of in the present Philosophy, are of an Abstracted Nature, as Matter, Figure, &c. and the particular Figures, as well as the particular sorts of Matter, are deriv'd from the different Combinations, Order, and Motions of the Parts of Similar

*An Uniform Force, or Velocity, affirm'd by this Philosophy.*

Cartes Princip. Par. 2. §. 36, 37, 38, 39, 40.  
Rohault Phys. Cap. 21. §. 6.  
Cap. 13, 14.  
Par. 1.

*An Uniform Motion, or Velocity, affirm'd by this Philosophy.*

Matter; it is therefore likewise necessary to conceive, that an Abstracted Motion is intended here, from whence, in Conjunction with the foregoing, the variety of Motions, or Forces are collected.

*Such a Velocity is immutable from any Concourse, tho' the Sums, or Aggregates of it may be changed.*

§. 10. It appears therefore to be certain, according to the Modern Philosophy, that if the whole Mass of Matter was to be divided into the Minutest Particles which were possible, each of 'em must be presum'd to be endu'd with the same Degree of Velocity, if the Particles are suppos'd equal; or in general, that the Motion of any Body would be originally proportional to its Matter, and equal Portions of Matter would have equal Velocities, and by consequence, let these Bodies, or Corpuscles act amongst themselves as long as we please, the same kind of Velocity would be still preserv'd, without any manner of Variation.

For let two parcels of Homogeneous Matter, which has no other Property than Solidity and Extension, &c. that is, has no Force, or Activity, excepting what it receives from this innate Velocity, be suppos'd equal; or, which is the same, since the Subject, in which these Velocities are inherent, is of no moment or importance in the present Case, let one Action be equal to another, the result, upon their Opposition, can only be this, that they will be mutually destroy'd; and therefore there can be no different Velocity or Action arise from thence; if they do not encounter each other, they will continue the same. Again, let us now suppose a Portion of Matter, which is as two, and another as three, the Motion of each will be in the same Proportion, but the Action or Velocity equal; if these be conceiv'd to meet each other, seeing the Sum of the Velocities, taken together, is = to 5, there will be 4 subtracted from that Sum, by the equal Opposition of 2 to 2, which leaves 1 Velocity, and consequently, tho' the Motion is diminish'd, which consists in the Sum of the

the Velocities; the Velocity it self is not, since in respect of Velocity, or real Action, or Force, 1 is = to 5, or 3, or 2, in Motion.

It may be said indeed, that the 1 Velocity is now communicated to a parcel of Matter, which had 2 Velocities before, and therefore it seems reasonable to think, that each of those Parcels of Matter will, after the Concourse, have only  $\frac{1}{2}$  the Velocity it had, but since Matter is presum'd to be an Abstracted Idea, and has only Solidity and Extension, &c. 1 Velocity where there is no Resistance will carry it as far as 2 or 20, or any other Number, or Sums of them; from whence we conclude, that in this Hypothesis there is not, nor cannot, be any encrease of the Force first impress'd upon Matter, but either it will be invariably the same, or else will be absolutely destroy'd: We shall reserve, what we have more to offer on this Head, to our Examination into the Laws of Motion and Velocity, which we have already written, and from whence we cannot but conclude, that such Laws, according to this Philosophy, are as much an Abstraction of the Mind, and therefore as imaginary, as Space or Matter are.

§. 11. If what is alledg'd in the preceding Section be true, it follows, that Motion, in it self, cannot contribute any thing to the Explaining the Variety of Tasts, and the several Distinctions they have, without introducing different Modifications of it, which we shall now examine; the Velocities of all the Parts of Body, we have prov'd, in this Hypothesis of Similar Matter, to be the same; either therefore the infinite Number of our Tasts arises from the changing Aggregates or Sums of these Velocities, or else, from their varying Determinations, and the diversity of the Figures, which they describe.

§. 12. The first cannot be significant to produce any Alteration in the perceptions of our Mind, because,

*Impossible that an Uniform Motion or Velocity should account for the difference we perceive in Tasts.*

*The differing Aggregates, or*



*Sums of the  
same Velocities  
cannot do it.*

because, for the Mind to be differently affected, it is necessary the Organs, whether the little nervous Fibrillæ, or whatever else conveys our Sensations to their Audience in the Brain, it is necessary they should receive Impressions distinct from one another, that is, that they should be differently mov'd, this seems to be no less than an Axiom; but where the Degree of the Velocities is alike, tho' the Sums are different, it is as evident as the other is an Axiom, that the same Fibrillæ cannot derive from thence a different Force, or Impression by what has been said in Sect. 5.

And if we consider the thing with the least Attention, we may as well affirm, that if a small Globe of Ivory strikes upon our Sense of Feeling, with a certain Degree of Velocity, and produces in us a determin'd Perception, be it what it will, another which is of a different Diameter, and the same Velocity, may produce Heat, another, Pain, and another still of other Dimensions, Cold, &c. than which there could be nothing more absurd; since it is plain, where the Matter and Velocity is the same, and the Dimensions different, there is, as in Solidity before, so in Motion now, only an Extension and Enlargement of the same Perception, for in this Example of Ivory, the Aggregates of the Velocities are suppos'd to be different, and the Velocity the same.

From whence we may rationally conclude, that the difference of these Aggregates or Sums of Velocity, can be of no service at all to us in solving these sorts of Phænomenons of Taste; since the Case of Ivory is much the same, with that which we are considering of Tasts, because there needs nothing more to make it exactly correspondent with it, unless instead of Ivory to substitute so many differing Dimensions of Similar and Homogeneous Matter.



§. 13. Neither is it possible, in the second place, *Nor yet the* that the various Determinations of the same Velocity, or Motion in this Philosophy, which terms *various Determinations of it.* may be us'd promiscuously, as we have shewn, in respect of their Effects upon us, should account for our Tasts, because all that the Mind is excited to observe from such Impressions made upon it, is barely to refer it self to and react upon the Impulse, and, as it were, to pursue that Direction in which the Force is impress'd; thus, if any thing strikes our Eyes, or our Feeling obliquely, or in a strait Line, we do not find any Difference in the Perception of the same Force or Velocity, except in its straitness or obliquity, as is, on the one hand, abundantly manifest from the Doctrine of Opticks, and on the other, from common Experience of judging by its Tendency and Determination, from whence any Action or Percussion, upon our Sense of Feeling, is deriv'd into our Minds.

And since a Circular, or any Polygonal Figure, is only made up of an Oblique, and a direct Description, if different Determinations cannot produce the Effects we are considering, different Figures will be equally incapable of it; I mention the Circular here in particular, because it was before alledg'd as the Cause of Heat, and from what has been here offer'd, with as little Reason as any other Figures or Determinations to explain Tasts; which, perhaps, are only another kind or certain Degree of Heat or Action, as Colours are of Light; however, what Tast, or Heat, or Colour is, and wherein it consists, we do not now enquire, and only endeavour at present to demonstrate what it is not.

§. 14. Lastly, if the Grossness or Magnitude of *Lastly, the different Figures of the Parts, are not sufficient to solve the Differences of Tasts.* the parts of Matter, or the different Determinations and Figures of their Motion, are unable to solve the several Phænomenons of Tast, there is nothing remaining in the Corpuscular Philosophy

Arg. 1.

to do it, unless the various Figures of the Parts which are mov'd: And to this end some are contriv'd into Pointed, others into Obtuse, a third sort into Ramous, a fourth into Globular Figures, and so on as there is occasion to Change and Mold them into one shape or another; But that this Invention is likewise insufficient appears from what has been alledg'd in the preceding Section, since the like Motion of differently figur'd Parts is answerable, and amounts to the same as the differently figur'd Motion or Determination of like Parts, which has been already confuted.

*The Different Figures of the Parts, not sufficient to solve the Difference of Tasts.*

Arg. 2.

§. 15. Besides in Matter of Fact, and our common Sensations, we are not aware, where Bodies act upon our Organs of Sense with the same Degree of Velocity, let the one be Triangular, the other Sphærical, and the last Pointed, we are not aware, nor do we perceive any other Distinction in these Applications of variously figur'd Bodies to our Senses, excepting what lies in the difference of the Figures themselves, but, as in Sect. 4. so here, there is good Reason for us to think, that the Proportion betwixt the Action of any Body, and the Perception of the Mind upon that Action is the same, whether we take a larger Circuit, or a smaller of our Organs of Sensation; thus if a Circular Basis of one Inch Diameter, acts with a certain Degree of Force upon the Organ of Sensation, which is likewise a Circle of one Inch Diameter, it will proportionably produce the same Perception in us, as if a Circular Basis of  $\frac{1}{2}$  of an Inch Diameter, should act with the same Degree of Force upon the Organ of Sensation, which is also only  $\frac{1}{2}$  of an Inch Diameter, that is, the Perception of the Mind would be the same in kind, tho' different in its Extension, as the active Body is greater or smaller, and the same Reasoning will hold, if the Inch is diminish'd to a Millionth or Nonillionth of it, so long as the Mind can distinguish

stinguish one Extension from another; and where that Distinction ceases, it will be so far from receiving different Sensations from the parts being suppos'd to be infinitely Minute, which this Philosophy would have recourse to, to baffle, I suppose, the pursuit of its Doctrines, that all Sensations, from such Corpuscles, must be exactly the same, since the Force is suppos'd equal, and the Difference in Extension not perceptible.

And this is confirm'd from all our Sensations of the same kind, thus Heat, or Colour, or Smoothness, or Solidity, &c. whether they are enlarg'd to a greater, or contracted to a less Dimension, are unchangeable in their Nature, and manner of affecting us.

§. 16. In fine, since Figure consists of various Modes of Extension, what Information the Mind can receive from it, is only that of Extension variously modify'd; for it would be absurd to imagine, that Extension should produce in us, the Idea of Heat, of Sounds, or Colours, and for the same Reason of Tasts, and we may as justly assert, that Heat produces Sound in us, or Sound Colours, or Colours Tasts, berwixt which there is not the least Connexion; but if Extension in general, singly and abstractedly consider'd, cannot cause the Sensation of Tast in us, Figure or the different Modes of Extension will be equally incapable of furnishing us with the several Species and Kinds of them.

*The Different Figures of the Parts, not sufficient to solve the Difference of Tasts.*

Arg. 3.

§. 17. Notwithstanding which, some Philosophers have been so abundantly convinc'd of the Truth and Reality of these Notions, that they have thought 'em sufficient to Trace the Tast of the Grape, in the several Periods of its Growth, from its being in the Tendrel, and in the Juice, which is drawn from the Earth, to its receiving its last Form and Maturity in the Vine; nor only this, they carry it still further, and imagine, that from these Principles also they can give us a clear

*An Examination of the Corpuscular Doctrine, in its Application to the Vine.*

Rohault. Cap. 24. §. 26, 27, 28, &c. Par. 1.

Explana-



Explanation of its change in fermenting, how it becomes Wine, and by what means, at length, it degenerates into a sharp and acid Substance.

*Why the Wood  
of the Vine is  
insipid not ex-  
plain'd.*

§. 18. The first Observation is, that the Wood of the Vine is insipid to the Taste, and the Reason assign'd is, because the Juice of the Earth, which rises into it, consists of the smallest and most minute Parts that can be, and therefore will affect the Palate but languidly and faintly; which account supposes, that as the Magnitude of these Parts increases, the Taste is proportionably more lively and strong, which is contrary to what we have already prov'd, and is also confuted by the following Explanations.

Another Reason alledg'd is, that the parts of the Succus are detain'd and entangl'd in the Pores of the Wood, and therefore are not at liberty to exert their Force upon our Organs of Sensation, which, being only an Incident, and not Essential to the Corpuscular Philosophy, as it affirms the Figures of the parts to be the Cause of our different Tastes, and which are by Consequence to be wholly disengag'd, and to obtain their own Force, it is not necessary for us to consider.

*Why the Grape  
is at first Taste-  
less, and after-  
wards acquires  
an Acidity, not  
explain'd.*

§. 19. The next thing observable is, that the unripe Grape, tho' it is likewise Tasteless at first, by Degrees acquires from the Heat of the Sun a kind of Acidity, which is said to proceed from the particles of the Succus coalescing, and their being by a certain Agitation loos'd, as it were, and set free from the Wood which detain'd them.

But what can be more Arbitrary, than to make the Parts, which are suppos'd to be the Causes of our Tastes, to adhere to each other, and at the same time to separate from the Wood, when there is only one similar Force introduc'd, namely, the Heat of the Sun to effect both? It is more reasonable to think, that, if such an External Action of the Sun is sufficient to disengage the Succus from  
the



the Wood, it will be likewise able to divide the parts of the Succus from each other, and if so, since the Minuteness of the parts was a reason of their being insipid, their being still more minute from their farther Division, instead of producing an Acidity to the Taste, will necessarily, according to this Hypothesis, render 'em still more imperceptible by us.

§. 20. And if these parts by the Continuance of the Sun's Action are broken, and the imaginary Points taken off, there will not Sweetness ensue to the Taste, as the same Hypothesis alledges, but a less capacity in them to affect our Organs of Sensation at all.

*Why the Grape by Degrees becomes Sweet, not explain'd.*

§. 21. Besides which, the Heat of the Sun is presum'd by its Action to alter the Figure of the parts of the Juice, which is nutritious to the Vine, and to be the cause of its Sweetness, whereas the Acidity of the same Juice, is resolv'd into the long Pores of the Wood, which, it seems, have the Power of forming the parts into a kind of Needles.

*This Account confused from comparing the several parts of it together.*

We will not dispute how oblong Tubular Pores can be a just Mold for pointed Parts, or how a Liquid, as the Succus is acknowledg'd, should adapt it self to the Dimension of those Pores, and Coagulate into the Figures they prescribe, since we may farther justly enquire by what Experiments it is known, that the Pores of any Plant or Vegetable are in strait or pointed Lines, and not anfractuons and broken?

But, if all this was granted, it seems a little unaccountable why Sweetness should proceed from an Active, and Acidity from a Passive Principle, the one from the Action of Heat, and the other from the bare Receptive Pores, which are contriv'd for it, when the last produces as lively and active a Sensation in us as the former; and after this, we do not need to pursue so extravagant and precarious

ous a Way of explaining, which this Philosophy proposes, in relation to the several changes a Vegetable undergoes, in order to its Ripening.

*That the Motion of the parts of Bodies alters the Figures or Magnitude of them, not always true.*

§. 22. We shall only farther take notice in Relation to this Doctrine, and it is what is fundamental to it, that it all along supposes, where there is an apparent Motion introduc'd amongst the parts of any Body, that the Figure of the parts are chang'd by that Motion; and yet there is nothing more demonstrably false, than such a Conclusion; for tho' Water or Gold are agitated in their several parts by Fire, so far as to cause an Ebullition, or a Fusion; yet no one ever thought, that from thence the Particles of either of them, were really chang'd into different Figures, any more, than if we should shake so many Grains of Wheat, or of Sand together, with the most Violent Motion, we should therefore imagine that they immediately lost their own Shape and Nature.

It is true, there is a change produc'd by the various Force of Action, but not by the Similar Motion of parts one amongst another, as is evident from the Instances alledg'd; from all which, if truly weigh'd and examin'd, it appears, that the Philosophy of a Similar and Homogeneous Matter and Motion is wholly incompetent, to furnish us with any tolerable Solution of the Phænomenons of Tasts; The next then we shall enquire into shall be those of Smells.

*Nothing different in the Hypothesis form'd for the Solution of Tasts and Smells, unless that the latter is oblig'd to add another concerning Effluvioms.*

§. 23. And it is very evident, that there is so sensible an Agreement betwixt our Tasts, and these, that what has been argu'd against the former, in relation to their proceeding from the Motion, Grossness, and Figure of the parts, will be equally valid against the latter; all therefore, which is peculiar in the Doctrine of Smells, is the Evaporation and Effluvioms of the Particles of Matter, in order to excite these kind of Sensations in us; to Taste any thing, it is only requisite to apply the

the Object to the Sensory by an immediate Contact, but in Smells the Case is quite different; since we are able to distinguish several of 'em to a great Distance, which has been thought impossible to be solv'd any other way, than by supposing very subtle Effluvi-ums sent out from the Odorous Body, and propagated in a Sphere from it, as from a certain and fixt Centre.

§. 24. Against which Hypothesis there are several Arguments; The first is, that these suppos'd Effluvi-ums, if there were any such, would equally affect the Pa'late, as they do our Nostrils, at the same Distance, which is contrary to what we Experience; for since the Effluvi-ums are parts of the Odorous Body, and every Body in the Corpuscular Philosophy is granted to consist of parts, which have their own proper Figure and Size belonging to them, and which distinguishes them from all others, the Motion or Velocity every where being already prov'd to be the same, it will be consequent, that these parts which are separated, be they Globular or Triangular, will either make like Impressions upon our Organs of Taste and Smelling at like Distances, or not; if they do, it is contrary to Matter of Fact; if they do not, it must be for this Reason, because the Organ of Taste is duller or more difficult of Impression than the other, but it is plain from Experience, that the same Parts with the same Motion do affect the Organ of Taste, as in *Alfa-foetida*, and therefore would be capable of doing it at a greater Distance, if there was nothing more to be consider'd than the Figure and Size, and Motion of the Parts of the Odorous Body; if there is any other Principle wanting, it is to be explain'd, it being manifest we cannot with any Reason acquiesce in these.

§. 25. And indeed there is another Principle wanting, *i. e.* the Cause and Reason of these Effluvi-ums, which cannot be deduc'd from any equal

*Rohault Cap. 25. §. 11, &c. Par. 1.*

*If the Hypothesis of Effluvi-ums was true, according to the Philosophy of Homogeneous Matter, we should Taste as well as Smell them, at equal distances.*

*If Effluvi-ums were granted the cause of*



*shew is not ex- plicated by this Philosophy.* ble Motion in all the parts of Matter in the Universe, and certainly not from the Figure or Solidity, and which is therefore a second Argument against this Philosophy, since, as we have prov'd, it affirms it, or if it do's not, that it gives no account of the Difference of Motion observable in Nature.

*The Impossibility of Effluvia, shewn from the Insensible Diminution of Odorous Bodies.*

*Rohault Cap. cirat. Mr. Boyle concerning Effluvia. Mr. Keil's Introduction. Lect. 5.*

§. 26. A Third Argument against them, which we may justly take notice of, is, the Impossibility of constant Effluvia from the Odorous Body, so as it should still preserve its Weight and Dimensions; In answer to this, Philosophers have labour'd mightily in Experiments, to prove that Odorous Bodies do lose of their Weight, as *Astætida* in particular, when it is expos'd to the Air; granting which, they do not yet evince, that the Parts go off in these imaginary Effluvia, since they may be really corroded from the Substance of Odorous Bodies, by the Violences of the *Æther*, as Salts are wash'd away by the Action of Water, or the Substance of Metals by the Spirit of Nitre, without supposing that any Effluvia fly off in the Circumscription of a Sphere; moreover, it is manifest, that several Bodies, which are not diminish'd in their Weight, do yet retain a constant Power of exciting a Sensation of Smell in us, as Cedar and Ambergrease in Solids, and we may, I believe, add in Fluids, the Volatile Spirits of Urine, Sal-Ammoniack, Harts-horn, &c. which, if any other Bodies, ought to be sensibly diminish'd from their exceeding Volatility.

*Effluvia not prov'd from the Infinite Divisibility of Matter, because Extension it self is not prov'd to be infinitely Divisible, or, if it was, it is no Ar-*

§. 27. A Fourth Argument we shall Mention, is, the incredible Expansion of Parts, which is necessary to this Doctrine of Effluvia, and the Inconsistency of it with the Corpuscular Philosophy; and here those, who defend it, endeavour to shew the Infinite or Wonderful Divisibility of Matter, the First from Mathematical Arguments, and the Last from Experimental; As for the Arguments from



from Mathematicks, of the Infinite Divisibility of Matter, viz. from the Nature of Incommensurables, from the Impossibility of two Parallel Lines meeting, tho' produc'd to Infinity, and yet the Possibility of drawing transverse Lines to cut a Perpendicular betwixt them in infinitum, from the Infinite Approach of the Asymptotes to the Hyperbola, from the Infinite Division of the Angles of Contact to a Curve, which, tho' infinitely less in one respect, are infinitely great in another, and the like:

*gument that Matter or Extension was ever actually so divided.*

*Robault Cap. 9. § 4, 5. Par. 1. Mr. Keil's Introduction, Lect. 3, 4.*

All these Arguments terminate only in this, That Extension, in an Abstracted Sense, is infinitely divisible; i. e. that the Mind sets no Bounds to it self, but can extend its Enquiries beyond what is really in Nature, as it can form a Centaur or a Chimæra; for tho' there is Extension, and it is evident the Mind can by its own Power consider the several Proportions of it, and it is really capable of those Proportions, yet it is not necessary that in Fact those Proportions, which it assigns, should really exist, such as the Mind considers them; thus I may divide a Yard, or a Foot, into 10 or 20 Parts by my Mind, notwithstanding which, that Number of Parts no more constitutes the whole, than 100 or 5000, which the Mind has an equal Power of dividing them into; and it is the same in Infinity, which entirely depends upon the Mind, and is no more Essential to Extension, than 100 or 1000, or any other Number, and is only so to the Mind's considering it. See §. 11, Chap. 4.

If, notwithstanding, an Infinity of Parts was a Property of Extension, and not of the Mind's considering it, that could never be a Proof of Matter and Extension, being actually divided to Infinity, because what is capable of being divided, does not infer a necessity of the Division; as a Cube of Ivory or Gold, or any other Matter, may be divided into a 100 parts, and yet that is no Argument that it actually is.

§. 28. There-

*Effluvia  
cannot be pro-  
ved from Mat-  
ter's being di-  
visible in Fact,  
to an incredible  
Minuteness.*

*Mr. Keil's In-  
troduction  
Lect. 5.*

*Mr. Boyle con-  
cerning Efflu-  
viums.*

*Cartes Princip.  
Par. 4. §. 152.  
153, &c.*

*The Expansion  
of Æther, or of  
the Dissolution  
of Copper, no  
Proof of an Ac-  
tual Division  
of Parts.*

*Mr. Keil's In-  
troduc. Lect.  
5.*

*Mr. Boyle con-  
cerning Efflu-  
viums.*

*Dr. Gregor.  
Astron. Prop. 3.  
Lib. 5.*

§. 28. Therefore these kind of Arguments are nothing to the real Existence of Effluvia of an Infinite Subtlety and Minuteness: The next Question is, Whether in Experiments, and by Matter of Fact, we can be convinc'd of it? To this end the Assertors of the Corpuscular Philosophy take a great deal of pains to prove, that a small Piece of Gold may be actually divided into several 100000 parts, that an *Æolipile* fill'd with Water, will emit Vapours for a considerable Time, which if it could do for some Hours, or a Day, is no manner of Explanation how a Solid Body should keep its Perfume entire, for 30, or a greater number of Years, as the same Philosophers of Effluvia acknowledge: And we cannot but here observe of the Loadstone, that they cannot give any Account of it, in respect of its Attractive Force, which continues undiminish'd, unless by supposing its Parts constantly to go off, and as constantly to return, which is a wonderful happiness to that Body in particular, which can send out, and call in its Emissaries, as it pleases, with as much Sagacity and Invention as the same Philosophers would have us'd in contriving that it should; and it seems to be very plain, that the Subtlety lyes rather in the latter than the former, rather in the Philosopher, than the Magnet.

§. 29. It is farther alledg'd from the Dissolution of Copper, that a small Piece of it is capable of giving a Tincture to a large quantity of the Menstruum which dissolves it, that the *Æther* at the distance of one of the Earth's Semidiameters, is infinitely expanded, so far, that a Globe of Air here, of one Inch Diameter, would there be sufficient to fill the whole Orb of *Saturn*, which is the remotest Planet from us; but neither of these Instances, nor any other which they bring, do in the least prove that there is an Actual Division of the Parts, and that it is not one uniform Expansion; but the Corpuscular Philosophy which asserts the Figures, and the

and the Definite Limits of the Parts of Matter, supposes a real Division of them.

§. 30. Besides which, Matter is confess'd, in this Philosophy, to be proportional to its Weight, and it is confirm'd by a multitude of Experiments, that Bodies will produce the Sensation of Smell in us for several Years, without any Diminution of their Gravity; and consequently either those Bodies have the same Gravity, and yet are diminish'd in their Matter, contrary to the receiv'd Maxim, That Matter is proportional to its Weight, or else they preserve the same Matter as well as Gravity, and then the Effluvia will not consist of any Matter at all, which is a more wonderful Expansion, and more incredible than the most surprizing we can think of, for all others are only an Expansion of a grosser Matter, into a more rarefy'd and fine; but this is an Expansion of No-matter, into some, or some Matter into none, and therefore may deservedly be admir'd.

§. 31. Granting therefore this Infinite Expansion of Matter, in the best Sense which can be put upon it, it will not yet solve the Infinite Subtlety of the present Effluvia, which are disputed; because, let us suppose a Similar and Homogeneous Matter, divided into an immense Number of Parts, as Copper, for Example, in its Dissolution; the Computation, which Philosophers give us of the Minuteness of these Parts, proceeds upon this Hypothesis, that a small Portion of the Metall possesses a great deal more Space, after its being dissolv'd, than it did before, that is, the Dimensions of the whole Menstruum, which is impossible; because if the Parts of the Copper, or any Homogeneous Matter, possess'd the Dimensions of the Menstruum, or another Homogeneous Matter, there would be a Penetration of Dimensions, i. e. two different Portions of Matter would exist together in the same Space, or else there would be some Parts of the

*Effluvia* confused from the receiv'd Maxim of Matter being proportional to its Weight.

*Effluvia* not prov'd from the Dissolutions of Copper, because if the Analogy obtains betwixt them, there will either be a Penetration of Dimensions, or such a wide Distance in the Parts separated, that they cannot account for the Doctrine of Effluvia, being every where dispers'd thro' the Space which surrounds the Odorous Body.



Menstruum which were not ting'd, contrary to the Experiment; for how colour'd Parts should illuminate the Intermediate Transparent ones is unexplained by a Similar Matter.

Besides, the parts of Copper, after Dissolution, continue the same Individual Parts, and therefore, tho' they are dispers'd, take up no more Space than they did when they were joyn'd and cemented together; thus, if we divide a Cubical Inch of Copper or Gold into 10 Millions of Parts, and place them distinct from one another, the Sum or Aggregate of the real Space they fill, will, notwithstanding this Dispersion, be no more, nor greater, than a Cubical Inch; from whence it is manifest, that such an Expansion, which the Corpuscular Philosophy, if it is consistent with it self, must affirm, will be of little Service to these Subtle Effluvia, since, if a millionth part of any Odorous Body was to be divided into 'em, all of 'em together would only take up a millionth of the Space, which that Odorous Body possess'd, and consequently would never be sufficient to account for those Sensations, which we perceive from it, in every part of Space, to a determin'd Sphere round it.

If it shall be said, that if we will not allow of this way of Explaining our Smells, there is no other possible way of solving them; we only answer, that we shall endeavour to shew that there is, when we come to give the true Philosophy of them.

*Effluvia, if it were not a Particular Hypothesis rais'd to solve a Difficulty, ought as well to obtain in Sounds, and Colours, as Smells.*

§. 32. Lastly, it is something strange, that we are so often told of these Effluvia, to excite the Sensation of Smell in us, when yet it was never so much as whisper'd to us, that there were any Effluvia from a Sonorous Body, to produce in us the distant Impressions of Colours or Sounds; the last of which, whether this Philosophy has better explain'd, we shall proceed to consider in the following Part of this Philosophy.



THE  
PRINCIPLES  
OF  
Natural Philosophy.

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PART II.

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CHAP. I.

*Concerning the Modern Accounts of Sounds.*

§. I. **T**HE more the Philosophy of Similar and homogeneous Matter recedes from it self, and deserts its own Principles, such is the unhappy Contrivance of it, the nearer it approaches to Truth, and gives us juster Explanations of things, not only without, but contrary to its own Design; an Example of which we have in Sounds, which are made to consist in a tremulous Motion of the Air, communicated to it from the Impressions of the Sonorous Bodies; so that small Corpuscles of a Certain Figure, Size and Motion, are acknowledged, in the present Case, to be of no Service or Advantage, and different Principles are apparently invented, to give a Solution to these kind of Phenomenons, namely, various Modes of Velocity and Motion, without considering the Magnitude or Figure of the Parts which are mov'd; and therefore is a plain Confession of the Incompetency of Homogeneous Matter, to furnish us with a Reasoning that is adequate to the full Latitude and Extent of Nature.

*The more the Philosophy of Similar Matter relinquishes its own Principles, the nearer it approaches to a just Solution of things, evident in Sounds.*

*How far the present Hypothesis of Sounds is to be admitted, and where in it fails.*

§. 2. As to the Hypothesis it self, it seems to come nearer to a true Philosophy, in resigning the whole Efficacy of Sounds upon our Perceptive Faculties, to some sort of Action or other, independent of, and abstracted from any little figur'd parts of Matter, which, as we have before endeavour'd to prove, can't produce any other Sensations in us, than those of Extension; but then in another respect, it is defective, that is, in assigning a wrong kind of Force, as a Cause of our Perceptions of Sound. It is a wrong kind of Force, because it supposes an Actual Motion is necessary to Sound, in the Sonorous Body, and then, that there must be a Vibrating or Reciprocation of that Motion, both which seem to be contradicted by Reason and Experience.

*Actual Motion in the Sonorous Body, not necessary to Sound.*  
Rohault Cap.  
26. §. 8, 9.

§. 3. That some Actual Motion or other is requir'd in the Sonorous Body, is endeavour'd to be prov'd from an Anvil, which, upon the Stroke of the Hammer, makes the small pieces of Iron or Steel, which lie upon its Superficies, to resule and recoil from it; and from the String of an Harp, which seems to have a manifest Motion, so as to be able to cause the Sensation of Sound in us; and to these Instances the others, which are made use of to evince the same thing, may be reduc'd; We readily own, that there must be a mutual Impulse, or Concourse, betwixt two Bodies to create a Perception of Sounds in our Minds, and therefore Motion will be necessary to bring them together, but this is not the Question; what is in dispute, is, Whether, after that Impulse, we are oblig'd to suppose the Sonorous Body must be endu'd with a Local Motion of its Parts, in order to communicate those Impressions to the Æther, which may be capable of exciting in us the present Phænomenons, which the Examples alledg'd do not prove.

§. 4. For

§. 4. For if it were evident in these Instances of the Anvil, and the String of an Harp, it would only shew, that Sound might be produc'd by the Intervention of Motion, but would not demonstrate that it could not be produc'd without it: Thus if we Evidence that the Fire, or Heat, has a power of Attraction, it will not from thence follow that all Attraction is caus'd by Heat; since it is too plain to be deny'd, that the Load-stone, and Matter in general, is furnish'd with that Power, where there is not any Heat residing; in like manner, if there can be one or more Cases affirm'd, in which, to our Senses, it is as manifest there is no Motion in the Sonorous Body, as it is thought undeniable, that in these there is, it will be consequent that Sound do's not essentially consist in Local Motion: But we have as just a Demonstration, from our Senses, that if we strike upon a Stone, Lead or Clay, and a hundred other Bodies, there is no Motion ensues, tho' we lay any small Grains of Sand or Steel upon them, as we have that there do's in striking upon an Anvil, or the Wire of a Virginal; and therefore we may reasonably infer, that there is some other Principle, which is the Cause of Sound, that is not Motion, and yet in which the Nature of Motion may be included.

*Not prov'd from the Instances of the Harp, and the Anvil, since there may be other Examples produc'd where no Motion is apparent.*

§. 5. Besides, if Local Motion is the Cause of Sound, there cannot be any Reason given, whatever Evasions are made, Why the moving of the Hand, in Æther, should not create the same Sensation in us; if it is said, there is no Vibration in such a Motion, that we shall afterwards consider; If, that the Motion is not strong and active enough, this Philosophy do's not introduce any different Forces, but supposes the same variously modify'd, either by the different Determinations and Figure of the Motion, or by the Vibration or Non-vibration of it; unless we acknowledge it enlarges its Principles, as the Phænomenons want a Solution,

*If Local Motion was the Cause of Sound, the Moving of the Hand in Æther ought to produce that Perception in us.*

and that it adopts new Forces into its Hypothesis, according as it finds occasion for them.

*An Actual Motion in the Sonorous Body, not possible, upon the Supposition of a Plenum, nor, if possible, would it be sufficient to explain the Phenomenons of Sound, and even upon the Supposition of a vacuum, not probable.*

Rohault Cap.  
17. §. 6. Par. 1.  
Fig. 6.

§. 6. Lastly, if Sound was deriv'd from an Actual Motion of the Sonorous Body, there is the same Reason why there should be an Actual Motion of the Medium, which communicates it, which would be impossible in a Plenum, a Favorite Doctrine of this Philosophy; for Instance, in the Motion of the Parts of an Anvil, they are continu'd, and adhere to each other, in that Motion, or not; if they are continu'd to each other, as the Parts, (which make up the Superficies on which the Percussion is) result, and rise into the Æther, the rest will necessarily follow, and consequently the whole Anvil will change its place at every Stroke, and to the same height as the Grains of Sand or Steel, which ly upon it, are repell'd, unless a greater Actual Motion or Velocity, can be communicated from a less; but this neither in one respect nor the other do we experience; if they are not continu'd, the Superficies (on which the Percussion is) must fly off from that which is immediately below it, which likewise is contrary to Matter of Fact; and since either of these Cases is absurd, it will be impossible that any room should be made for an Actual Motion of the Æther, which is necessary to an Actual Motion in a Plenum. And if there could be room for such a Motion, a Plenum would determine the Æther a quite different way, from our Organs of Sensation, whilst it took a Circular Direction, namely, by succeeding into the Space which was left vacant by the Actual Motion of the parts of the Anvil: what has been last said, is applicable also to the Vibrating Motion of any other Body. Lastly, if a Vacuum is suppos'd, there is no reason to believe the parts of the Anvil move, because they are Elastic, unless Elasticity consists in an Actual Motion, rather than a Repressure, which is only a Conatus, or Effort towards one,

§. 7. The



§. 7. The next thing we shall examine in this *Vibration being* Doctrine, is, the Vibration it asserts, as that which *only a Repeti-* is the peculiar Cause of Sounds, against which *tion of the same* there lies this Invincible Argument, and is indeed *Motion, cannot* a most undoubted Axiom, That that Force or Mo- *produce Sound,* tion, which is in it self singly incapable of ma- *if Motion with-* king an Impression upon the Mind, cannot do it *out such a Vi-* by any Repetition whatsoever; for, if our Organs *bration cannot* are alike dispos'd to receive the Strokes of exter- *do it.* nal Objects, and those are constantly the same; *Rohault Cap.* where the Cause is uniformly so, the Effect can- *26. §. 16.* not be different; thus, if from the Action of Light or Colour, or any other Quality in Bodies, we perceive a Brightness, or the determin'd Ideas of Red or Green, let those Actions be repeated never so often upon our Senses, we do not find any Change or Alteration in our Perceptions from them; so on the contrary, if any Motion is too languid and unactive to affect us, it will not be rais'd into a greater Energy, by a Perseverance in it, as in the continual Pulses of our own Arteries, we are not sensible of any Sound from thence, tho' they beat every Minute we exist.

§. 8. Indeed this Doctrine seems to be rather *This Hypothesis* form'd for an Explication of certain kinds of Sound, *is fitter to ex-* which are attended with a Ringing, and which *plicate the Na-* dwell upon our Organs of Sense for some Time, *ture of certain* as those of a Bell, or a Violin, than for a general *kinds of Sound,* Account of Sound, of which there are other Spe- *than Sound in* cies widely remote from the former, and do not *general* seem capable of being reduc'd to the same Principle of Vibration; for tho' it is Natural enough to imagin, that a trembling in the Note of any Sonorous Body do's proceed from a quick Vibration of its Parts, yet where there is only a flat and dead Sound, without such a Tremor, it is scarcely to be suppos'd that *that* should; or, that the striking upon Clay, should cause the same Vibrating Effect, as striking upon an Harp, or an Anvil.

*If Vibration is not the Cause but the Sign of a Motion, capable to produce Sound it is both a False and a Preposterous Solution.*

§. 9. Farther, if it should be said, that a Tremulous or Vibrating Motion is the Cause of Sound, not from the Repetition of the same Force upon the Mind, but because where there is a Reciprocation of Motion, it is an Indication or Sign that such a Motion is stronger, and more forcible than ordinary, and therefore may be sufficient to excite in us the Perceptions of Sound, which other Motions could not do: If this way is taken to defend the Solutions of the Modern Philosophy (which yet I am apt to believe the Assertors of it never intended) there will be this notwithstanding to oppose against it, that there are Vibrations, as in Pendulums, and the Vibrating Strings of Watches, where no Sounds are consequent upon them, and Sounds where there is no sensible or even imaginable Vibration, as in Bodies which are call'd Viscous, which are so far from having a resilient Force to any Percussion, that they cling fast many times, and adhere close to it: However, should we acknowledge all that can be desir'd, namely, that every Body which produces Sound in us, has some Degree of Vibration, and that such a Vibration is not the Cause of Sound, but a Sign that there is a Force in the Body, sufficient to raise that Sensation in our Minds, it would yet be an unreasonable and preposterous way in Philosophy to assign the Effect, as Vibration in this Case would be, instead of the Cause, to give a Solution of another Effect, as Sound, which proceeded from the same Cause; and we might as justly take Sound to explain Vibration, as this, to explain the other.

But more than this, if the Original Cause of Vibration and Sound, is a Difference in the real Force and Action of Sonorous Bodies, from that which is in Bodies that are not Sonorous, what is there alledg'd, in the present Philosophy, to give us the least Account, how one Body is distinguish'd from another, in its Innate Force and

Acti-

Activity? Especially when, as we have before prov'd, it must assert, if it is consistent with it self, one Uniform Motion and Velocity, dispers'd thro' all Matter, at its being first actuated by the Almighty Agent.

§. 10. It would be unnecessary after this to confute the several Experiments, which are brought to confirm the present Hypothesis, tho' we cannot forbear mentioning some of them; the first is, that Bells, the Anvil, the String of an Harp, Wood, and all Bodies in general, which have a resilient Force, are capable of producing Sound in us, to which this Philosophy immediately subjoins, therefore those Bodies, which want that resilient Force, cause a very weak one, as Lead and Dirt; which cannot but appear to be a strange and surprizing way of Arguing, that because a resilient Force is productive of Sounds, a Non-resilient one is so too.

§. 11. Another Experiment is, that of the Explosion of Gunpowder, and Pulvis Fulminans, to make which Square with this Reasoning, a Vibration of the Air is contriv'd, upon the Supposition of a Plenum, so Arbitrary and Chimerical, that Nothing can be more so; first an imaginary Plenum is suppos'd, then, that by the Action of the Gunpowder a subtle Matter is express'd from the Grosser, which unites with the Flame; afterwards, that the thicker Parts of the Air, being condens'd from the Action of the Flame, by their own Weight or Pondus, return to the place from which they were repuls'd, and being there again condens'd, by the Violence of their return, recoil back to that to which they were originally forc'd: When in the mean time both the Plenum wants to be prov'd, and in particular, this remarkable Condensation and Expansion, since, upon drawing the Sucker of a Syringe, or upon any other Motion in a Plenum, from which no Sound results, there is the same reason to affirm both in some Degree.

And

*The inconsistency of this Philosophy with it self, and its own Experiments.*

Rohault Cap. 26. §. 16, 23, 24. Par. 1.

*The Explosion of Gunpowder, with the Sound it produces, examined.*

Rohault Cap. 26. §. 30.



And lastly, how there should be any Motion at all in a Plenum, where Matter is imagin'd to be Similar and alike, is inconceivable.

*The Analogy  
between the Vi-  
brations of a  
Sonorous Body,  
and a Pendu-  
lous, consider'd.*

Rohault Cap.  
26. §. 38, 42.  
Par. 1.

§. 12. But that which this Philosophy seems to be more singularly pleas'd with, is the exacting the Vibrations of a Sonorous Body to the Laws of a Pendulous; in which this insuperable difficulty occurs, that in the Vibrations of the same Wire, the first will have a greater Velocity than those which succeed, and consequently must produce different Sounds; since this Philosophy affirms that acute Sounds consist in a quicker, and Grave in a slower Motion, but this is contrary to what we Experience; the only answer to which, and to prove the Motion or Velocity equable and alike, is, that the slowness of the Motion, in the last Oscillations, makes the Vibrating Wire describe a shorter Space in the same time, which a quicker Motion in the first will do in a longer, from whence it is apparent, that to assert an equable Motion, or Velocity in the Vibrations of the Wire, it is thought necessary to introduce and acknowledge a quicker, and a slower, that is, a different.

Besides which, to what purpose is it, that this Philosophy would shew different Motions are perform'd in the same time, to produce in us the same Perceptions of Sound? when it is not the equality of Time, but the Identity of Motion or Velocity, which must create in us the same invariable Perceptions, according to its present Confessions.

*The Laws of  
Pendulums ex-  
plain'd.*  
Rohault Cap.  
26. §. 43.  
Par. 1.

§. 13. Notwithstanding this, it goes on to explain to us the Laws of the Pendulum, one of which is, that those Pendulums which are of an equal Length, every thing else being suppos'd equal, perform their Oscillations in the same time, and that those which are of an unequal Length, in different Times; so, that the Numbers of their Oscillations will in the same time be in a Reci-  
procal



reciprocal Proportion of the Square-Roots of their Lengths, and by Consequence, if the Lengths are as 4 and 16, the Numbers of Oscillation, in the same time, will be as 4 and 2, that is, the shorter Pendulum will describe 4 Oscillations, whilst the longer describes only 2; and in general, the shorter Pendulums will describe a greater Number of Oscillations (in the same time) than the longer; or the shorter Pendulums will describe their Oscillations in a shorter Time, and on the other hand, the longer Pendulums in a longer, so that on the other hand, as the Numbers of Oscillations before were in a reciprocal, the Times, in the present Case, will be in a direct Proportion of the Square-Roots of their Lengths.

§. 14. From whence it would follow, altho' the String of an Harp, or a Virginal has the same Tension; First, that if it is of different Lengths, it must produce different Sounds, since, upon any Percussion, it is necessarily suppos'd to act from one and the same Center of Suspension, and two different Centers of Oscillation; and second, that if it is of the same Length, and struck in different Parts, where the Tension is the same, it should cause a Difference in Notes, for the same Reason, both which are contrary to Experience. 'Tis true, if the Center of Suspension is alter'd, that is, if the Terms of the same String, or different ones, are mov'd nearer or farther from each other, the Tension is likewise alter'd, and therefore a Difference in Sounds will result from thence, but that is not consider'd in this Philosophy.

§. 15. And yet, notwithstanding these Difficulties seem to ly against it, all the Confirmation of this Doctrine is resolv'd into two Instances only of its Solutions. The first of which is, that from hence we may account for the various Modulations of the Voice; for the Epiglottis being rais'd by the Air, which is expell'd out of the Lungs in Expiration, and

*Contradicted by Experiments in Sounds, so far as they are apply'd to explain Sounds.*

*The different Modulations of the Voice explain'd, from considering the Epiglottis as a kind of Pendulum.*

Rohault Cap.

26. §. 44.

Par. 1.

and then falling back upon the *Aspera Arteria*, its Motion upon the Root, on which it Vibrates, is imagin'd to bear some resemblance to the Swings of a Pendulum; and therefore, since in Children the Epiglottis is shorter than in adult Persons, suitable to the Nature of the Pendulum, it must necessarily move quicker in the one Case, and slower in the other, which is the Reason, why the Voice of a Child is acuter and shriller than a Mans; so likewise sometimes a part of the same Epiglottis may be only rais'd, which will consequently form a shorter kind of Pendulum, and sometimes the whole, according to the different Quantities of the Air, which is expell'd from the Lungs; from whence will follow, if this Reasoning be true, a variety of Notes, which will have a sharp, or a graver Sound in proportion, as a smaller, or a larger Length of the Epiglottis is made to Vibrate.

*The Solution  
from thence  
invalid.*

§. 16. How ingeniously soever this Solution may appear to be contriv'd, there will not be yet found any solid Truth in it, both upon the account of what has been before said concerning Pendulums, and Vibration in general, and their unaptness to furnish us with a due Explication of Sounds, as well, as because it do's not absolutely agree with that Doctrine.

For the Epiglottis being nearly in a parallel situation to the Horizon, will rather resemble a *Vectis*, whose Center of Gravity is in the Root, or that portion of the Epiglottis, on which it turns, than a Pendulum, but the Properties of a *Vectis* are of another Nature from those which are laid down in this Explanation; for the same Force, at different Distances from the Center of Gravity, receives Moments, which are greater in a direct Proportion of its removal from it, and therefore, if we suppose this *Vectis* to be so balanc'd upon its Centre of Gravity, by a certain Antagonist Action in the Muscles, as to be in an *Æquilibrium*, which we may

may as reasonably presume, as that it swings upon a Center of Suspension with all the Liberty of a Pendulum, it will follow, that the Air, which is forc'd out of the Lungs, if it strikes upon a longer Epiglottis, or a larger portion of the same Epiglottis, will produce an acute Sound, instead of the Grave, which is assign'd it, and that consequently Men would have shriller Voices than Children, contrary to the Phænomenon; for, since Acuteness of Sound is said to consist in the quickness of Velocity, it is evident, that in an *Æquilibrium* a longer Vectis will describe a larger Arch, in the same time that a shorter Vectis do's a smaller, and therefore the Velocity, in the former Case, will be greater than in the latter.

Not to mention the Arbitrary way that is here us'd, of raising sometimes the whole Epiglottis, and sometimes a part of it only, to make so many different Centers of Suspension for these imaginary Pendulums, whereas from the Cartilaginous and Stubborn contexture of the Epiglottis, it seems plain that there is no such Compliance in it, or can be expected from it.

§. 17. The second Instance is that of the Sym-*The Instance*  
pathy, which is observ'd betwixt two Unisons of *of Unisons in*  
different Harps, upon the moving of one of which *two different*  
the other apparently trembles and emits a Sound, *Harps con-*  
tho' it be plac'd at some small Distance from it, *fused.*  
which is thought to consist in the Similar Motion *Rohault Cap.*  
or Vibrations, which are by the Mediation of the *26. §. 45.*  
Air communicated from the one to the other; but  
such a Solution seems to be deficient on several  
Accounts.

First, Because it lays down for a Principle, that where Bodies have a capacity of Vibrating alike, if one actually do's vibrate, it must of consequence produce a similar Vibration in the other, which is not universally true, since if we take Pendulums of the same Length, which have that capacity, the  
effect



effect do's not follow, (upon the Supposition, that one is put into Motion,) of the others moving too. Second, Because, if it were true, that capacity of a similar Vibration in the Unison, which is not mov'd, is not explain'd, upon which yet the actual Vibration of it must be confess'd to depend. Third, Because, if an actual Vibration is capable of influencing another, which has an equal Propensity to vibrate with it self, *à fortiori*, it must be sufficient to produce an actual Vibration in that Body, which has originally a greater Propensity to vibrate than it self, that is, which is already prepar'd to receive the least Impression from any External Action upon it; thus, for Instance, if we suppose, with this Philosophy, that a grave Sound, Abstracting from every thing else, proceeds from a slower Velocity, and an acute one from a quicker, it will be necessary for us to affirm, that a quicker Velocity can produce a slower, if it can produce an equal; and consequently, that the String of an Harp, which has an Acute Sound, must act upon another, which has a Grave, with a greater Force, and make it vibrate more strongly than any other String, which has the same Sound with it self, which yet is contradicted by Experience.

*If Vibrations cannot explain Sounds, it cannot likewise the Propagation of 'em.*

§. 18. If therefore the Doctrine of Vibrations, and of Pendulums, is not sufficient to give us a just account of the Reason of Sounds, any Propagation of 'em, which is deriv'd from thence, must be likewise incompetent, and without a true Foundation in Nature or Philosophy.

*The propagation of Sounds, by a Vibration, continu'd thro' the Medium, is precarious and groundless.*

§. 19. 'Tis said indeed, in general, that the Parts of a tremulous Body, by their impulse, will urge and propell the Parts of the Medium, which lye next it, and by that means compress and condense them, and by their return, or receding in the same tremulous or vibrating Motion, that they permit the parts of the Medium proportionably to retire and expand themselves, where the Medium is Elastic



lick, and consequently, that the same Law of a Reciprocation of Motion obtains, in the next adjoining Parts of the Medium, in respect of the former, as the former did in respect of the tremulous Body, and so in infinitum.

Robust Cap.  
26. §. 25.  
Dr Clark's  
Annot.  
Sir Is. Newt.  
Princip. Lib. 2.  
Prop. 43.

As for propagating Sounds this way, it is not any thing to the purpose, unless they are prov'd to consist in Vibration, the contrary of which we have endeavour'd to evince; and unless it be affirm'd, that Bodies, which have a different Force of Elasticity, observe the same Method of Communicating their Impressions to those which are next them; which will be, to say no more, at least very hard to demonstrate; for it is no ways reasonable to suppose or imagine the Elasticity of a Bell, or the String of a Harp, observes the same Law in Communicating its Vibrations to the *Æther*, as the *Æther* its Vibrations to *Æther*; since, if it do's, the Elasticity of a Bell may make the same Impressions upon the String of a Harp, as upon *Æther*; for it is the same in the Actions of Bodies, whether a different Action is propagated, as that of a Bell, or the String of a Harp, thro' the parts of the same Body, as that of *Æther*, and yet in parts of *Æther* preserve the same Action, which was first impress'd from a different, or whether two different Actions, as those of a Bell, or the String of a Harp communicate their Actions to one another.

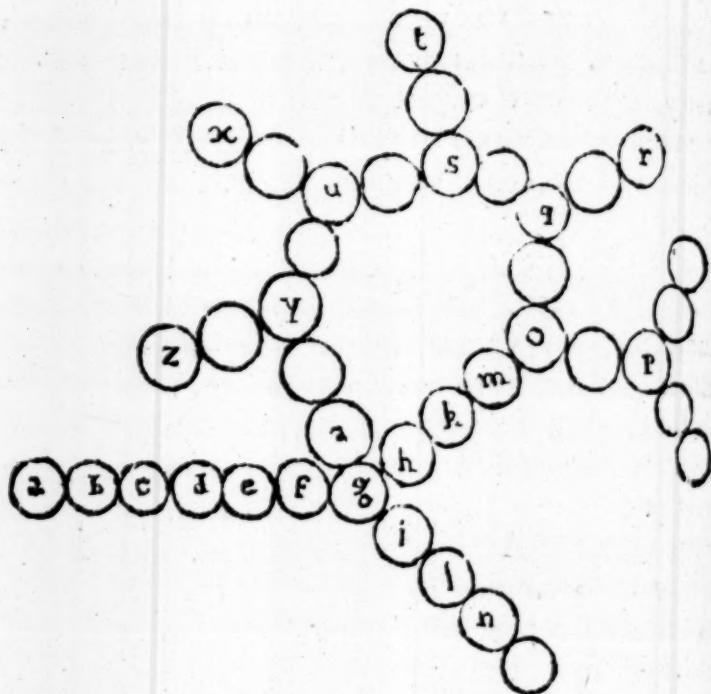
§. 20. However, since this Philosophy is still defended by those, who have with a great deal of Geometry and Pains refin'd upon the Corpuscular; we shall consider it, as it hath been propos'd to us, to the best Advantage, and Trace the several steps of it, in that new Method which has been contriv'd for it, to make it appear with the semblance of a Demonstration.

*That Pressure is not promoted or carry'd on thro' a Fluid in right Lines, unless where the Particles of the Fluid lye in directum. explain'd.*

The first Proposition therefore which it alledges, in order to explain the Propagation of Sounds, is, that Pressure is not promoted or carry'd on thro' a Fluid

Sir H. Newt. a Fluid in right Lines, unless where the Particles  
 Princip. Prop. of the Fluid lye in directum. Thus, in Fig. 1<sup>st</sup>.  
 41. Lib. 2. if the parts of a Fluid lye in a direct Position, as  
*a, b, c, d, e, &c.* the Pressure will be continu'd ac-  
 cording to that Situation, but if at *g*, it strikes  
 obliquely upon the parts *h* and *i*, it will be diffus'd  
 into the parts *h, k, m, o*, on the one hand, and

Fig. 1.



*i, l, n, o* on the other, till it meets with other ob-  
 lique parts, as at *o*, and then it will pass to *p* and *q*,  
 at *q* supposing it impinges upon others, the Dire-  
 ction of it will be then from *q* to *r* and *s*, from  
*s* to *t* and *u*, from *u* to *x* and *y*, and from *y* to  
 and *a* in infinitum, and so the several other Branches  
 will likewise perform their peculiar Provinces of  
 dispersing the pressure of those Points, which these  
 are imagin'd not to reach. Q. E. D.

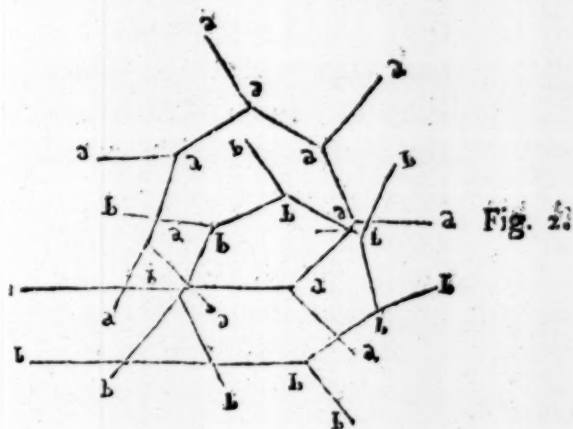
The foregoing  
 Proposition ex-  
 amin'd and  
 refuted.

Arg. 1.  
 From its de-

§. 21. But against this Demonstration, as it is  
 term'd, there are these Difficulties to be objected,  
 First, That it presumes the Corpuscular Philoso-  
 phy to be true, and that the Medium consists of  
 certain

certain determin'd and figur'd Parts, for if there was no Distinction of Parts, there would be no Distinction of a Strait or an oblique Situation, in respect of one another, excepting in our Imaginations, since they would be all resolv'd into one undistinguish'd Continuity, which would be Similar and Homogeneous thro' the whole; for if there is no real Distinction in the parts of a Fluid, and an Arbitrary Division of the Mind is allow'd, we may divide them so as the same parts shall be in an oblique Position, in one respect, and in a direct, in another, unless they are suppos'd to be reduc'd to indivisibles, and then it is evident, there is no such thing as direct or oblique in the indivisibles themselves, since they will not have so much as Parts, Figure, or Determination.

Second, It is to be observ'd, that there would not from hence ensue a Propagation of Pressure, but a confus'd Interruption of it; for if we suppose 100, or 1000, or a Million of Lines, drawn from so many points of the Sonorous Body, parallel to *a, b, c, d, e, &c.* all acting at once, and in the same Divarications with those before express'd, their Pressures would so far interfere with each other, that, in a Multitude of Instances; they would demonstrably oppose their mutual Actions, which would effectually hinder an uniform Progress of the several Pressures thro' the given Fluid; thus *wherever* the Pressures *aaaaaa, bbbbbb, &c.* represented by Fig. 2. which, in its



confusedness, is a just resemblance of this kind of Reasoning, *wherever* they cross'd each other, they

would destroy, in some Measure, according to their several Directions, those very Pressures, which were design'd to propagate and disperse the Action; in-  
somuch, that if their several Mæanders were exact-  
ly trac'd, there would sensibly be as many actual  
Oppositions to the progress of the Pressure thro'  
the Fluid, as there would be efforts to promote it;  
but in any place where the Pressure is stop'd, all  
the Particles that succeed, will be entirely depriv'd  
of its Influence, which little agrees with the Uni-  
formity of the Propagation of it, at least, where-  
ever the Pressures are communicated in the same  
time, and meet each other; which would also ob-  
tain in general, if they are suppos'd to be imparted  
in an instant thro' the whole Medium.

Arg. 3.  
*From its not  
corresponding  
with Experi-  
ments com-  
monly known.*

Third, This Explanation no ways agrees with  
the Circular Expansion of a Fluid, for which it  
endeavours to account, unless the irregular Figures,  
before delineated, can by any Art or Skill be re-  
duc'd to Fig. 3. or 4. where the Pressure is propa-  
gated in Concentric Circles, as is manifestly ex-  
perienc'd in stagnating  
Fluids, by projecting  
any thing into them;  
whereas, according to  
the enormous Laws of  
propagating Pressure in  
Fig. 1. and 2. it would  
not be Circular but an-  
fractuous and broken,  
and go into several con-  
fus'd Lines, instead of  
even and uniform Circles.

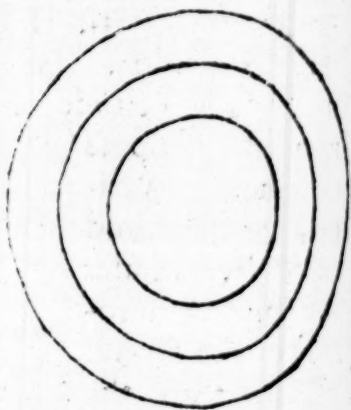


Fig. 3.

Arg. 4.  
*From its incon-  
sistency with  
the Reasoning  
made use of  
in the second  
Proposition.*

Fourth, Nor do's it correspond with what is  
afterwards pretended in Fig. 4. that *de* pressing  
upon *fg*, and *fg* pressing upon *hi*, (which produces a  
Re-pressure or Re-action equal to the Action,) causes  
a lateral Pressure in *fg*, towards *N* and *K*, since in  
Fig. 1. *b* presses upon *c*, and *c* upon *d*, as likewise,  
*h* upon



$h$  upon  $k$ , and  $k$  on  $m$ , and yet both  $c$  and  $k$  are not suppos'd to be retarded in their Progressive or Rectilineal Motion, so as to be determin'd betwixt  $d$  and  $b$  on the one hand, or betwixt  $b$  and  $m$  on the other, to a lateral Pressure, and the Reason or rather Artifice is plain, because, in the former Instance, a direct Pressure could not be other ways so well asserted, and in the latter upon the account of the Obstacle  $LM$  a lateral could not.

Lastly, It is surprizing, that the Propagation of Sound shou'd be it self explicated by Pressure, when Sound is suppos'd to consist in an actual Vibrating Motion; since a flat Pressure is extremely different from a Force, which acts by results.

§. 22. The second Proposition in this Doctrine, which is call'd a Corollary to the former, is, that supposing there is any Obstacle as  $LM$  to intercept the Propagation of the Pressure, explain'd in the foregoing Section, if there is yet any Communication, as thro' the passage  $BC$ , the Medium

Arg. 5.  
From its Dis-  
agreement with  
the Principles  
it is brought  
to explain.

The Propaga-  
tion of Pressure  
thro' a Medi-  
um. where an  
Obstacle is in-  
terpos'd, how  
said to be per-  
form'd.

Sir Is. Newt.  
Prop. 41. Lib.  
2. Corol.

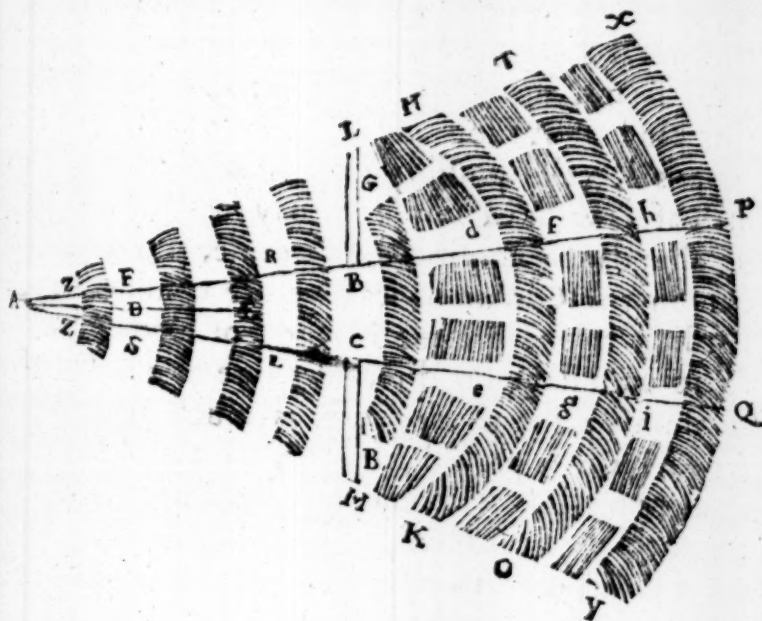


Fig. 4.

which lies behind such an Obstacle will equally propagate the Pressure to all parts; how this can

be deduc'd from what went before, will not be easily conceiv'd, and therefore a new Demonstration is invented for it, viz. that the Cone *Ade*, presses upon the frustum of the Cone *defg*, and that upon *fghi*, but since Action and Re-action is the same, *fghi* will repress as much as *defg* presses upon it, and consequently betwixt the Pressure of the Cone *Ade*, and the Re-pressure of *fghi*, the frustum of the Cone *defg*, not finding the like Resistance on the parts *N* and *K*, must recede by a lateral Pressure.

Arg. 1.

*The preceding Account refused from its inconsistency with the Reasoning made use of in Prop. 1.*

§. 23. To which it is answer'd, First, that since the frustum of the Cone *defg*, by this way of Reasoning, is suppos'd to be laterally press'd to *N* and *K*, by the same way of Reasoning *FRLS*, or any other frustum, on this side the Obstacle, should receive the like Determination, which would not in the least agree with the Hypothesis explain'd in Fig. 1. where it is taken for granted, that every Pressure is in a direct Line, if the parts of the Fluid are so, which in the present Case lies in several Radius's drawn from the point *A*.

Arg. 2.

*From the Impossibility of Pressure's being propagated at all, upon the Principle of Action and Reaction.*

It seems, secondly, very unreasonable to allow this kind of Action and Re-action, which is here propos'd, (tho' possibly in Mechanics, which we shall afterwards examine, it may in a different Sense be abundantly confirm'd,) because, if this Law was true in the Circumstances we are considering, according to the present Method of Demonstration, there would be no direct Pressure at all, but a lateral only; for if *defg*, is as much repress'd by *hfgi*, as it is press'd forwards by the Cone *Ade*, it is impossible it should proceed, since it would, by such an equal Compression, be oblig'd to spend its whole Force to the Sides *N* and *K*; and seeing *fghi*, by this suppos'd Re-action presses back upon *dfge*, *hPQi* will not be sensible of any Pressure, unless *fghi* can actually press forwards at the same time that it actually presses backwards; and

and if we carry this Pressure to its Original in *A*, we shall find that there cannot be so much as a Lateral, that is, there will be no Propagation of Pressure to any part, but it will languish and sink in the first advance, which it makes from the impelling Body; for the Re-action in *A*, being equal to the Action, there is as great a Power to hinder its Progress, as there is to enforce it, which, what it can produce besides an actual Stop to the primary Impulse, we cannot readily comprehend.

For it is not sufficient here to say, that *fg hi* Arg. 3. may repress to *defg*, by the Law of Action and Re-action, and yet by Impulse press forwards to *hi PQ*, since the Impulse is the Action, and Re-action or Resistance being equal to that Impulse, those Forces must be in equal Balance with each other; and if Resistance or Re-action does not hinder the Propagation of Impulse, then Action is superior to Re-action, which contradicts the receiv'd Maxim of their being equal; on the other hand, if any Instances are produc'd where there is an Action two contrary Ways, as is suppos'd in the Concourse of certain, either hard and resisting, or Elastick Bodies; in the first Case of hard Bodies, if their Forces are equal, a perfect Quiescence would ensue, answerable to what we affirm would be the result of a Pressure and Repressure here, or else, if the impelling Body is superior to the Resistance of the Body impell'd, all the Consequence from thence will be, that a quiescent Force, which proceeds from Pressure and Re-pressure, is determin'd one way, by a Superiority of Action in the Impellent, not that the Body impell'd, when it is in Motion, actually presses two contrary ways; for the Pressure of the Impellent compensates the Re-pressure of the impell'd, so that after its Determination one way, there is no Re-pressure at all; and thus *Ade* after impulse, does not press upon *defg*, since it is compensated by its Re-pressure, but

*From the Propagation of Action upon the Supposition of an equal Re-action, being in it self impossible, and not prov'd from the mutual Concourse and Impulse of Bodies, whether Hard or Elastick.*

Dr. Wallis  
De Percussione Prop. 1.

an actual Pressure, after Impulse, is suppos'd in the present Demonstration; that is, altho', after the first Impulse, all the parts *defg*, *fghi*, &c. will be Quiescent, yet they are presum'd to be Active, and to exert a positive Pressure thro' the whole Fluid, which it is evident they do not.

As to the 2d Case of Elastick Bodies, they, after Impulse, are likewise determin'd one way or another, and do not act two different ways at the same time, there being so much lost to the Force of one Body, which is acquir'd to another, suitable to the Laws and Proportions of their Actings, which we shall afterwards consider.

We shall farther add, that such Reasonings, notwithstanding they have been objected to me, are beside the Question, since here the Properties of Pressure in the Abstract are only consider'd, but in the Instances alledg'd, Hard and Elastick Bodies are introduc'd, which can signify nothing to the present Inquiry; unless the Doctrine of the Propagation of Sounds, thro' a Fluid Medium, is the same as that of Mechanicks, and the mutual Concourse or Moments of Bodies, which are not Fluid; that is, unless the Corpuscular Philosophy is true, and all Matter, whether Fluid or not, is the same.

Arg. 4.  
From an equal  
Action and Re-  
action, not  
causing Propa-  
gation of Mo-  
tion in any  
respect.

Moreover Action and Re-action are not applicable to the Propagation of Pressure or Motion,



upon this plain Account; because that Law concerns only the equal Poise and Balance of either, but



but a Law affirm'd to prove an *Æquilibrium* of Action, can never extend to a Propagation of Action, where the Propagation of it must necessarily infer a Superiority of an Action to the Resistance or Re-action it meets with.

To explain this farther, Let *A* and *B* be two Bodies, which mutually attract each other with an equal Force, or which is the same, let the Action in *A*, from *E* to *A*, be equal to the Action of *B*, from *E* to *B*, this will be the same as Action being equal to Re-action; as therefore *A* acted from *E* to *A*, and *B* from *E* to *B*, in Fig. 5. so let *EA* be now suppos'd to draw *A* towards *B*, and *EB*, *B* towards *A*, and there will be exactly the same Force of Action equal to Re-action, in Fig. 6. which will only change their Denominations into the Pressure and Re-pressure, which we at present consider, that is, *A* will press against *B*, and on the contrary *B* against *A*, with the equal Forces of *EA* and *EB*; supposing therefore two adjoining Bodies as *C* and *D*; if, because Action is equal to Re-action, *A* presses upon *D*, or *B* upon *C*, with the same Force, as *A* and *B* press upon each other, it will follow, that two Bodies which are drawn together, and made to act upon each other, shall not act upon each other any more than two Bodies, which are not drawn together as *C* and *D*, and are not made to act upon each other; how therefore such a Law, which only concerns the equal Forces of Bodies, as *A* and *B* opposing each other, can be apply'd to the Communicating a Pressure to *D* or *C*, which they are not oppos'd to, will not be readily demonstrated. Fig. 4.

Granting notwithstanding all that has been deny'd, if *defg* press'd upon *fg hi*, on the one hand, and *hi PQ* repress'd on the other, by which means *fg hi* was oblig'd to recede towards *N* and *K*, there will be the same Demonstration concerning *defg*, *hi PQ*, and the rest of the Divisions mark'd out in

Fig. 4.

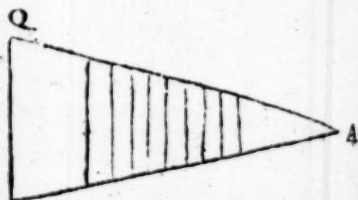
Arg. 5.

That if this Reasoning prevail'd, all the frustums of the Cone would be press'd out of it, and the

*Action would remain every where, but in the Cone is self.*

in Fig. 4<sup>th</sup>. Let us therefore now conceive the same Figure to be divided into infinitely small Frustums of a Cone; since, according to this way of arguing,

every Frustum ought to retire laterally to *N* and *K*, all the minutest Lines that can be imagin'd being consider'd as so many Frustums, will be immediately thrust *P*



out, and expell'd from *APQ*, seeing the several Frustums of the Cone, are determin'd to a lateral Direction; if not, this Philosophy should inform us, which of these Frustums or Lines will continue in the Cone, and which be laterally driven from it.

This therefore is likewise an evident Proof, as we had one before, in the present Doctrine of Pressure, that this kind of Reasoning, from a Division of a Fluid into parts, can never be of any service to the furnishing us with a true Knowledge of things, since a Distinction into parts supposes a Difference in the parts, which are divided, as in the Case before us; whereas no reason can be assign'd in the same Homogeneous Fluid, why one part should differ from another, and some Frustums recede in a lateral Direction, whilst others stay to expel them.

Arg. 6.

*From its being, as is said, a Corollary only of the former Proposition, which has been already confuted.*

*The Demonstration that all Motion propagated thro' a Fluid, departs from a direct Determination into Spaces.*

If this farther is a Corollary to the first Proposition, as it is said to be, it will be involv'd in its Fate, and where that has been prov'd to be false, this cannot be true.

§. 24. Another Proposition in this Doctrine, is, that all Motion, propagated thro' a Fluid, departs from a direct Determination into Spaces, which are unmoy'd; and the first Instance is of Water, in respect of which it is evident in Fact, that when any Motion is impress'd upon that Fluid, it dilates it self into circular Waves, from the Centre of

of its Motion, and is thus explain'd from Fig. 4<sup>th</sup>; *which are un-*  
 that supposing *fg, hi, PQ*, to be the several *mov'd, ex-*  
 Waves, and the Spaces which are not mark'd by *plain'd.*  
 Lines, or by transverse ones, the Valleys or Lacunæ, *Sir Is. Newt.*  
 or small Indentations betwixt them, that the Motion *Princip. Prop.*  
 also is only propagated in the Cone *APQ*; since the *42. Lib. 2.*  
 Waves *fg, hi, &c.* are higher than *N, T, X*, on *Caf. 1.*  
 the one hand, or *K, O, Y*, on the other, *viz.* the Parts  
 of the Fluid, which are suppos'd not to be mov'd,  
 they will by their own Gravity descend into those  
 Parts, and since the Spaces betwixt *Gd, Nf*, and  
*Be, Kg*, betwixt *Nf, Th*, and *Kg, Oi*, &c. in  
 the Stagnant Fluid, are respectively higher than the  
 Lacunæ *defg, fghi* in the moving, the Stagnant  
 Fluid will descend into the Lacunæ of the mo-  
 ving, by which means, as in the former Case, the  
 Ridges, or the Waves will be propagated from  
*fg, hi, &c.* to *N, T, X*, and *K, O, Y*, the Stagnant  
 Fluid, so the Lacunæ will in the latter, by the  
 Stagnant Fluid's *GdfN, NfhT, &c.* descending  
 into the Spaces *defg, fghi, &c.* which are lower;  
 and that all this will be done in an instant, is prov'd,  
 because the Descents of the Ridges into the Stag-  
 nant Fluid, and those of the Stagnant Fluid into  
 the Lacunæ, will be perform'd with the same  
 Velocity, as the Original Motion is impress'd.  
*Q. E. D.*

§. 25. Which, altho' it has the Characteristick *The foregoing*  
 of a Demonstration annex to it, seems to be liable *Demonstration*  
 to a Confutation in several respects. First, Because *refuted.*  
 it is not consistent with the Propagation of Pres- *Arg. 1.*  
 sure, thro' a Medium, which this Philosophy as- *From its not a-*  
 serts, as is very manifest, if the present Solution *agreeing with*  
 is compar'd with the former; but the Propagation *the Account be-*  
 of Motion is the same in effect, as that of Pres- *fore alledg'd of*  
 sure is in its Conatus, unless some other Principles *the Propaga-*  
 are introduc'd, as Gravity and Descent here; in *tion of Pressure,*  
 opposition to which, we say, where the Propaga- *and its Intro-*  
 tion of Pressure or Motion in the Abstract is con- *ducing Princi-*  
 sider'd, *ples foreign to*  
*Motion, in ar-*



der to explain  
its Propaga-  
tion.

Arg. 2.

From its not ac-  
counting for the  
Descent of the  
Waves into the  
Stagnant Fluid.

sider'd, it is both irrational to introduce any new Principle, as Gravity or Descent, and contrary to a true Philosophy, to explain the same or like Effects, as the Propagation of Pressure or Motion, from different Causes, namely, from Action and Reaction in one Case, and Gravity in another.

Secondly, the Descent of the Ridges *fg*, *hi*, &c. into the Stagnant Fluids *eB*, *gK*, *iO*, on the one hand, and *dG*, *Nf*, *hT* on the other, is not solv'd, since if Action and Reaction was not equal, so as to keep up *fg* on each side, which this Philosophy affirms, there could be no lateral Direction, much less a Reason assign'd why *fg*, *hi*, &c. should separate so exactly, that one half should divide to the parts *Gd*, *Nf*, *Tb*, and the other to *eB*, *gK*, *iO*, and not diffuse themselves towards *PQ*, as well as towards *GNT*, *MKO*.

Granting farther the new Principle of Gravity, which is introduc'd to explain the present Propagation of Pressure or of Motion thro' the Fluid, it is not yet consequent, nor can by any Method be prov'd, that *fg*, *hi*, &c. will rather descend to *dG*, *eB*, *fN*, *gK*, than into the Lacunæ comprehended betwixt *fg*, *hi*, &c. since the Waves or Ridges *fg*, *hi*, will not only have the advantage of their own gravitating Force, to fill up the intermediate Lacunæ, but that of the Direct Impulse from *A*, which if it has a power to cause a Repressure, as is pretended, that is, a contrary Action to its own, so far as to throw off the Motion of the Fluid into a Lateral Direction, it must of necessity have as good a Force to make any other obey its own; since either these two Forces of Action and Reaction will be in an equal poise, and the Fluid left to gravitate into the Lacunæ of the Cone, or else the Action will be superior to the Reaction, and by that means promote the Gravitation of the Waves into the Lacunæ, rather than into the Stagnant Fluid.

Lastly,



Lastly, allowing what has been hitherto disprov'd, it will not from thence follow, that the Ridges *fg, hi, &c.* should propagate themselves in a Circle, or any portion of it; for the Impulse at *A*, if made according to the Direct Line *AD*, is not prov'd to proceed with an equal Force, or Inclination in the Oblique *AF* or *AS*; on the contrary, at the same time that the Oblique Impulse propagates its Action to *F* and *S*, the Direct may promote its Action as far as *E*, the last, in reason, obtaining a greater Velocity than the first, which would be far from giving a Solution of the Circular Waves propagated in Water, from a single Impulse in the Apex of a Cone.

Thirdly, The Descent of the Stagnant Fluid Arg. 3. into the Valleys, or Indentations of the Moving, *From its not accounting for the Descent of the Stagnant Fluid into the Lacuna of the Moving.* is still more unintelligible; for, besides the Circular Direction in this Case, as well as the former, being unaccounted for, the Pressure and Re-pressure being disprov'd, and the Incongruity of this Exposition, with what has been affirm'd before, in the Propagation of Pressure, how is it possible, or likely, that *GdNf*, or *NfTh*, and their Correspondent Stagnant Fluids *egBK, OgiK*, should by their own proper Gravity, and the Velocity they receive from the Original Impulse in *A*, just fill the Lacunæ *defg, fghi*, so as an equal Indentation or Lacuna, shall be propagated to the Stagnant parts of the Fluid? If that can be done, let the Stagnant Fluid *GdNf, BeKg* be 10 times as large as the Moving *degf, fghi*, 5 parts of Water, or any other Fluid, may be equal to  $\frac{1}{2}$ , or  $10=1$ ; since if *GNdf* is  $=$  to 5, and *dfeg* is  $=$  1, there will be the Descent of 5 parts of Water into the  $\frac{1}{2}$  of *defg*, and 10 into the whole  $=$  1, to make the Lacunæ *gdfN, &c.* for so much as *gdfN* discharges of its Fluid into  $\frac{1}{2}$  *defg*, its Lacuna will be increas'd in that proportion, and  $\frac{1}{2}$  *defg* rais'd in its Indentation in the Cone.

And

And by the same Reasoning, if the Stagnant Fluid be never so large, and the Moving never so small, the Descent of the Stagnant Fluid, into the Lacunæ of the moving, will of it self make as large Lacunæ or Furrows in the Stagnant Fluid, by emptying it self into the small ones in the moving, as if the small ones had been a 1000 or a Million times greater, and altho'  $defg$  is infinitely small,  $GNfd$  may have an infinitely large Lacuna, which is impossible.

Arg. 4.

*From its not accounting for the Dilatation of the Waves in one and the same Instant of Time.*

As to the Time of the Propagation of this Motion thro' Water, it is not so easily conceiv'd that it should not want to be explain'd; for if the Ridges  $fg, hi, \&c.$  descend into the Lacunæ of the Stagnant Fluid, and  $GNdf, NTfb$  into the Lacunæ of the moving, by their own proper Gravity, the Impulse in  $A$  can signify nothing to that Descent, unless originally in forming the Ridges and Lacunæ, and therefore it is not necessary that the Dilatation of the Waves should be perform'd with the same Velocity with which the Waves  $fg, \&c.$  are impell'd; since the proper Gravity of the Waves may be the same, where the Impulse is different, and therefore may descend quicker or slower, that is, may be propagated to the Stagnant Fluid in a greater or less Time, than the Waves  $fg, hi, \&c.$  proceed or go forward, contrary to Experience; if the Waves  $fg, hi, \&c.$  do not descend by their own Gravity, but from the Impulse in  $A$ , and in proportion to that, then it would cause the Wave  $fg$  to descend into the Lacuna  $fg, hi, \&c.$  from whence it would follow, that there would neither be a Dilatation of the Ridges or the Lacunæ; but the Stagnant Water would still continue so, and the succeeding Waves would in their turns fill up their intermediate Lacunæ in the Cone, according as they were impell'd into them,

Fifthly.

Fifthly, This Explanation would cause a sensible retrograde Motion in the Fluid, or else no sensible Ridges and Indentations at all; for whilst *defg, hi*, tended towards *GNT*, &c. *GdNf, TNfh*, &c. would take a contrary Current towards *df*, and *fh*, which must be as visible to us, as the Dilatation of the Waves and their Lacunæ, since it is the suppos'd Method of their being dilated, nothing of which we experience; for if the Dilatations are not visible, the Waves are not, unless Waves which are dilated, can be perceiv'd without being dilated, which is on the other hand contrary to the direct Information of our Senses.

Arg. 5.

*From its being contradicted by our Senses.*

Sixthly, The very Original Supposition, upon which this Reasoning depends, is one of the greatest Difficulties in it, and wants as much an Explication as the Propagation of the Waves in the Stagnant Fluid, namely, the Propagation of them in the Moving, which, before the Impulse in *A*, was stagnant; for in the Impelling Point *A* there are no Ridges or Lacunæ to produce them in the stagnant Cone; what Method or Art then do's Nature use here, from one single Moving Point, to propagate the Valleys and Ridges, namely, from *A*, in a Direct Line to *PQ*? but this we must take for granted, which in truth is the very Problem, and ought, in a Real, and not a Chimerical, Philosophy, to be solv'd on the same Principles, with the other which it is introduc'd to account for; that is, the Ridges and Lacunæ in the Stagnant Fluid, are accounted for from the Ridges and Lacunæ in the Cone, whereas the Ridges and Lacunæ in the Cone it self are not in the least explain'd.

Arg. 6.

*From its not explaining how the Ridges and Lacuna are produc'd in the Cone.*

§. 26. Conformable to this Demonstration is that of the Propagation of the pulses of a Tremulous Body, thro' an Elastick Medium, in which the Pulsations are imagin'd to be promoted, by successive and alternate Rarefactions and Condensations of it; so that as *fg, hi, PQ*, before

*The Doctrine of the Propagation of Motion thro' Water, apply'd to the Æther, consider'd as an Elastick*

repre-



*Fluid, explain'd.*

Sir Iſ. Newt.  
Princip. Prop.  
42. Caf. 2.  
Lib. 2.

represented the Ridges, where was the greateſt quantity of Water, and the Interſtices betwixt them, the Valleys, where was the leaſt; ſo now the former ſhould deſcribe to us the denſeſt and thickeſt part of the Medium compr'eſs'd together, by the Actions of the Pulſes, and the latter the rareſt and thinneſt, which is expanded towards *A* upon the Interval of every Pulſation; from whence it follows, that *fg, hi, PQ* the parts of the Medium, which are forc'd into a narrower Space, dilate and exert themſelves into the Fluid, which is unmov'd, and therefore not compr'eſs'd, namely, towards the parts *dG, fN, hT*, and upon the Intermiſſion of each Pulſe, relax themſelves towards the Apex of the Cone *A*; And this Propagation to all ſides will be uniform, and agreeable with the Direct; becauſe the Pulſes *fg, hi, PQ* will dilate themſelves with the ſame Celerity towards *dG, fN, hT*, as they advance from the Point *A*, from whence they are deriv'd.

*A Confutation of the preceding Doctrine.*

§. 27. It is very evident, that this Account of Motion, propagated thro' an Elaftick Medium, is answerable to that of Motion propagated thro' Water, and is explain'd from that Hypotheſis, and therefore the ſeveral Arguments which are produc'd againſt the one, changing only the Terms of Deſcent in the Ridges of the Water, for the Expansion of the Elaftick Fluid, which is conſtipated and condens'd, will be equally valid againſt the other, namely,

Arg. 1.

From its not agreeing with the Propagation of Preſſure. §. 20, 21.

Arg. 2.

From its not agreeing with Art. 2. §. 25.

Arg. 3.

From its not

First, That the Expansion of *fg, hi, PQ* into the parts *G, N, T* and *X*, which are not compr'eſs'd, is not agreeable to the Propagation of Preſſure before aſſerted, §. 20, 21.

Secondly, That for the ſeveral Reaſons alledg'd under the ſecond Head of §. 25, the Expansions of *fg, hi, PQ*, will either not be laterally determin'd, or if they are, they will not be in a Circular Direction.

Thirdly, In the Rarefaction, or Expansion of the Elaftick and Quieſcent Fluid, *GNdf, TNfb*,  
Gf.



&c. we are wholly to seek for an Explanation, *explaining how*  
 since if  $PQ$  returns into  $PQhi$ ,  $hi$  into  $hifg$ , *the Stagnant*  
 $fg$  into  $fgde$ , with a Repressure that is equal to *Fluid can be*  
 their several Pressures from  $A$ ; they will effectually hinder  $GdfN$ ,  $fNbt$ , &c. from exerting *press'd or ex-*  
 themselves into  $defg$ ,  $fgbi$  the rarefy'd Spaces of *panded into the*  
 the Cone; because  $fg$ ,  $hi$ , &c. being the com- *Moving.*  
 press'd Fluid, will have a greater Force of Recoiling  
 into the rarify'd Spaces, than that part of the Fluid  
 which is not compress'd, as  $GdfN$ ; if  $PQ$  do's not  
 immediately return into  $hiPQ$ ,  $hi$  into  $fgbi$ , yet  
 since the Action and Reaction betwixt them is equal,  
 there will be an Action in the rarefy'd Spaces  $hiPQ$ ,  
 &c. = to the Re-action in  $PQ$ , and consequently  
 sufficient to keep the external Fluid  $TXPh$ , &c.  
 from pressing into the Cone; on the contrary, if the  
 Action and Re-action betwixt the rarefy'd and con-  
 dens'd Spaces is not equal, there can be no lateral  
 Pressure, or Condensation in  $XPTh$ , &c. as this Phi-  
 losophy acknowledges; since  $PQ$ , and the same  
 may be said of the rest, will rather repress to-  
 wards  $hi$ , than recede to  $PX$ : But if  $GdfN$ ,  
 $Nfbt$ , &c. cannot press into the Cone  $defg$ ,  
 $fgbi$ , &c. it will follow, that these Rarefactions  
 and Condensations will not be equally propagated,  
 seeing the Rarefactions and Condensations will be  
 alternate within the Cone  $APQ$ , but not so in  
 the Fluid, which is external to it.

Besides, if  $hi$ ,  $PQ$ , &c. could give a liberty  
 to  $TXhP$ , &c. to expand themselves into the Cone,  
 they would at the same time permit a regress to  $PQ$ ,  
 towards  $A$ ; that is, the same impellent Force,  
 which keeps  $PQ$  from returning to  $hi$ , will al-  
 so keep a weaker and stagnant Elastick, as  $ThXP$   
 out of the same Space; or, which is the same, if  
 there is no Pressure upon  $PQ$ , it will recoil to-  
 wards  $A$ , and hinder the Expansion of  $TXhP$  into  
 the Cone, if there is, and Pressure is propagated  
 every way, which is affirm'd in this Philosophy,  
 there

there will be the same likewise upon  $bP$ , so as to buoy up the Stagnant Medium, and obstruct its entrance into the Cone  $AQP$ .

Arg. 4.

*From Impulse,  
not agreeing  
with this way  
of Propaga-  
tion.*

Fourthly, Either the Condensation of the Elastick Fluid is propagated by the Impulse from  $A$ , or not, so as the Condensations in  $GdfN$ ;  $bTPX$ , should be perform'd at the same time as the Condensations in  $fg$ ,  $hi$ ,  $PQ$ ; if it depends upon the Velocity of the Impulse, it will not be consequent that the Rarefaction and Expansion of  $fg$ ,  $hi$ ,  $PQ$  into the Spaces  $dGfN$ ,  $bTPX$ , are perform'd in the same time as  $fg$ ,  $hi$ ,  $PQ$  are condens'd, unless the Archs  $fg$ , &c. are equal to the Triple, Quadruple, or any other multiple of them; for upon this Supposition  $dGfN$ , &c. cannot be condens'd quicker than according to the Velocities of  $fg$ , &c. and where there is the same Force in  $fg$ , &c. respectively towards their sides, there cannot be a greater in  $GdNf$ , &c. respectively, than what is communicated from thence; that is,  $gf$ ,  $hi$ ,  $PQ$  would just propagate their Velocity of Expansion, equal to the Velocity of Condensation, namely, the Archs in  $GdfN$ ,  $bTPX$  would be in their Condensation from the Expansion of  $fg$ ,  $hi$ ,  $PQ$ , equal to those Archs in the same time of Propagation of the Impulse; that is  $GdfN$ , if greater, might require a much greater time to propagate its Action in, than  $defg$ , notwithstanding by this Doctrine it should be done in the same, and at one Impulse.

If this Propagation of Motion, thro' the Elastick Fluid, do's not depend upon the Velocity of the Impulse in the several Condensations of  $fg$ ,  $hi$ , &c. The Medium must be suppos'd to acquire a new Force, different from the Impulse, which is not explain'd, that is, that it exerts it self without any Impelling Cause.

Arg. 5.

Fifthly, If  $fNGd$ ,  $bTNf$ , could be suppos'd to penetrate into the Spaces  $fdeg$ ,  $bfgi$ , which by

by Division the Third of this Section they cannot do, yet there would be a retrograde, and consequently an Elastick Motion in the Fluid, from  $df, fh$ , towards  $GN, NT$ , as well as from  $d$  to  $G$ ,  $f$  to  $N, h$  to  $T$ , &c. and as it follows, a lateral Condensation and Rarefaction, as well as a Direct, which is represented by the transverse Lines in Fig. 4<sup>th</sup>, which would cause such an immense confusion in the Rarefactions and Condensations of the Fluid, that it is much to be question'd, whether there would be any at all, since they would oppose each other, in so many Instances, that one would be apt to think the best way for 'em would be, to be quiescent by Concert.

Lastly, There is no Explication given how a Tremulous Body should condense and rarefy the Medium, in that manner as is suppos'd; for how  $fg, hi$ , &c. in the Cone, should be condens'd, and the intermediate Spaces expanded, cannot be explain'd by the same Methods by which  $Gd, fN, hT$ , which ly out of the Cone, are condens'd, and their intermediate Spaces expanded, since the last are accounted for upon the Supposition of the former; but upon what Reason that Supposition is founded, we are left to enquire, altho', as was said before, both the one and the other, ought, in a true Philosophy, to depend upon the same Principles.

\* §. 28. Besides what has been said, in relation to the Analogy betwixt the Propagation of Motion in Water, and an Elastick Fluid, we are farther to consider, how such a Motion is, or can be promoted thro' the Cone  $APQ$ , so as to solve the Dilatation of it, to the other parts of the Fluid, which are stagnant.

And First, this cannot be done from any Comparison with Water, because the Motion of it in Waves, thro'  $APQ$ , could not be accounted for from a bare Impulse in  $A$ , by Arg. 6<sup>th</sup> §. 25, and Arg. 6<sup>th</sup> of the foregoing Section; and in the next place, because an Elastick Fluid cannot have the same Properties with that, which is suppos'd not to be so, as Water.



Secondly, The Tremulous Motion in the Apex of the Cone consists of a repetition only of one Pulse, let us therefore examine what Effect the first would naturally have in an Elastick Medium.

Arg. 7.

*From the Impossibility of such a Rarefaction and Condensation.*

Let it therefore for the present be confess'd, that, by its Action, it would produce a Condensation in  $ZZ$ ; but for the same Reason  $ZZ$  ought by its Pressure towards  $PQ$  to condense  $ZZFS$ , and that  $FRLS$ , so likewise behind the Obstacle  $LM$ , *de* should cause a Constipation in  $defg$ , and that in  $fgbi$ , and so on; from whence, whilst the Pressure of the first Pulse continu'd, there would be a Condensation propagated thro' the whole Elastick Fluid, without any Distinction: Let now the Pressure of the impelling Point or Body be taken off, that is, let there be an Intermission of the Pulse, and  $ZZ$  will retire to  $A$  by its own Expansion, and at the same Instant  $FSZZ$  to the place from whence it was expell'd,  $RLFS$  to  $FSZZ$ ,  $bifg$  to  $fgde$ , &c; so that a universal and equable Expansion of the Fluid will ensue, as before an equable Condensation; Let us now suppose a 2<sup>d</sup> or 3<sup>d</sup> Pulse, and their Correspondent Interruptions, there will be only a repetition of the same Effect, that is, successive Rarefactions and Condensations propagated thro' the whole Cone  $APQ$ ; since, in every Intermission of the Pulse, the Elastick Fluid restores it self to its pristine state, from which it is again disturb'd by the following Vibration; which is widely remote from what is represented to us in Fig. 4<sup>th</sup>, where the Rarefactions and Condensations are checker'd and interwoven, as it were, with each other; whereas it is impossible that the Rarefaction and Condensation should exist together, but the one is evidently superseded as the other is introduc'd, and they alternately succeed into each other's place.

Arg. 8.

*From the Cone  $APQ$ , being arbitrarily assum'd.*

Farther, both in Water, and the present Elastick Medium, a Cone is arbitrarily taken in Distinction to the rest of the Fluid, which is suppos'd stagnant, whereas



whereas if  $A$  by its Impulse can make the Waves  $ZZ$ ,  $FS$ ,  $RL$ , and the Lacunæ betwixt them, on the one hand, or the Condensations and Rarefactions express'd by them on the other, it will be impossible to assign a Reason, why it may not do it in a larger Cone as  $LAM$ , and consequently in one still of a greater Capacity; to fix therefore the Limits, or Boundaries of the Moving Fluid, exclusive of the Stagnant, will be a Difficulty not to be surmounted by this Hypothesis. Again, when afterwards the Impulse arrives at  $BC$ , there can be no Demonstration, that every point in the said Line has not the Properties of the Impellent  $A$ ; for, since in this Case every point in  $BC$  is an Impellent, it cannot be shewn why each of 'em should not have a Cone of a Moving Fluid appertain to 'em, as well as the Point  $A$ ; and in general, every Point thro' the whole Cone  $APQ$  may be an Impellent in its turn, and therefore it seems unreasonable on that account also to acquiesce in the present Doctrine; for if this may be done, since all the Properties of the Moving Fluid in the Cone are suppos'd, the Propagation of Motion thro' the whole Fluid, resolv'd into such Cones, would be only likewise explain'd, by supposing it.

Lastly, if several of these Points  $A$  are suppos'd Arg. 9. to be mov'd together, as in the Sonorous Body is acknowledg'd, they will produce a Figure as confus'd as the former in Pressure, where several Points were consider'd, as acting in Conjunction. See Fig. 2<sup>d</sup>.

*From the Confusion, which several Points acting as from A would produce.*

§. 29. To conclude, supposing each part of the Medium had, as is imagin'd, an Oscillatory Force distinct to it self, and propagated from the Vibration in  $A$ , it would not be by a Rarefaction and Condensation of the Elastick Fluid, but by a Tremor, conceiv'd in the infinitely small Portions of it, without any Distinction of Rare or Dense, for the Tremulous Body, which causes Sound, is not contracted

Arg. 10. *From the Tremor in the Sonorous Body communicating only a local Motion to the Fluid without condensing it.*

tracted or expanded in its Parts, and at the most has only a local Motion; and for the same Reason, if *de, fg, hi, P Q*, produce the same effect of Sound, it is reasonable to believe it is not by a Rarefaction and Condensation, but such a local tremulous Motion likewise.

*This Doctrine  
not confirm'd  
from the Ex-  
periments of  
Unisons.*

Sir Is. Newt.  
Princip. Prop.  
50. Lib. 2.  
Schol. p. 369.

§. 30. This reasoning, notwithstanding, is said to be confirm'd from the Tremblings produc'd in Bodies, which are oppos'd to a Sonorous one, as the shaking of Windows from the Sound of a Drum, and that of the Strings of Harps from their Unisons; but these Instances do not prove that the Medium is rarefy'd and condens'd, in the Method before explain'd, but that a Tremor is excited in it, suitable to the Vibrations of the Sonorous Body, by one uniform Pulse and Re-pulse, explain'd in Arg. 7. §. 28. and in §. 29. and as to the Celerity of Vibration, and that of Unisons. See §. 13, 14, 17.

*Not confirm'd  
from a Com-  
putation of the  
Velocity of  
Sounds.*

Sir Is. Newt.  
Princip. Prop.  
50. Lib. 2.  
Schol. p. 370.

§. 31. It is also thought to be evinc'd from a Computation of the Velocity of Sounds, upon these Principles, which agrees with Experiments made concerning it; The Computation is, that in a 2d of time, or the 60th part of a Minute, Sound is propagated 968 Feet, the Experiments affirm, that it is carry'd in the same time 600, others, that it is 1474, and according to the exactest, more than 920, and fewer than 1085, within which limits 968 lies.

*The Computa-  
tion explain'd.*  
Abridgment  
of Mr. Boyle,  
Vol. 1. p. 373.  
Sir Is. Newt.  
Princip. Prop.  
50. Lib. 2.  
Schol. P. 370.  
Prop. 49. Lib.  
2. p. 368.  
Prop. 24. Lib.  
2. Corol. 4.  
p. 304.

§. 32. As to what respects this Calculation, it is as follows, That since the Specifick Gravities of Rain-water, and Quick-silver, are as 1 to  $13\frac{2}{3}$ , or thereabout, that is, as 1 to  $13\frac{2}{3}$ , as has been experimented by weighing them in a Glass bubble, and since Air, which is capable of supporting the Mercury in the Barometer to 30 Inches, is, in its Specifick Gravity, to Rain-water, as 1 to 850, the Specifick Weights of Air and Quick-silver, by multiplying  $13\frac{2}{3}$  into 850, will be as 1 to 11617, or rather, as 1 to  $11616\frac{2}{3}$ ; Therefore the Height of

of the Quick-silver, in the Tube, being 30 Inches, the Heighth of the Air, supposing it uniform, whose Weight presses upon that, in which we are conversant, by multiplying 30 into  $11616\frac{2}{3}$ , will be 348500 Inches, or 29042 Feet nearly, that is  $29041\frac{2}{3}$ .

In order farther to justify the Calculation, affirm'd in the preceding Section, of Sound's being propagated to 968 Feet in a second of time, we are referr'd to a Problem in Prop. 49. where, the Density and the Elastick Force of a Medium being given, the Velocity of the Pulses is determin'd; For let us suppose a Medium to be compress'd by an incumbent Weight, in like manner as our Air is imagin'd to be, and let the altitude of the Medium, consider'd as Homogeneous, be  $A$ , whose Weight is equal to the Weight which compresses, and whose Density is the same with the Density of the Medium compress'd, for in it the Pulses, if any, are propagated; Let us moreover suppose a Pendulum, whose Length, betwixt the point of Suspension and the Centre of Oscillation, is  $A$ ; in the time in which such a Pendulum performs its Oscillation, made up of its progress and return, in the same, the Pulse will describe a Space, equal to the Circumference of a Circle describ'd by the Radius  $A$ .

It being therefore before prov'd, that the Heighth of the Air, suppos'd to be uniform, is 29042 Feet, this is the Altitude which in the foregoing Problem is represented by  $A$ ; and the Circumference describ'd by the Radius  $A$ , or 29042 Feet, by multiplying it into something more than 6, according to the proportion betwixt the Radius and Circumference, will be 182476 Feet; And since a Pendulum, which is 39 Inches and  $\frac{1}{3}$  long, Compleats its Oscillation, made up of its progress and return, in 2 Seconds of Time, a Pendulum which is 29042 Feet, or 348500 Inches long,



long, will finish a like Oscillation in 188 Seconds of Time, and  $\frac{4}{5}$ <sup>th</sup>, seeing the Lengths of the Pendulums, other things being equal, are as the Squares of the Times, that is, as  $39\frac{1}{2} : 348500 :: 2 |^2$ .  $188\frac{4}{5} |^2$ . From hence therefore it is said to follow, that Sound will be propagated in a Circle to 182476 Feet, in 188 $\frac{4}{5}$  Seconds of Time, and by Consequence to 968 Feet in 1.

*The Calculation not just upon several Accounts.*

Abridgement of Mr. Boyle, Vol. 1. p. 372, 373.

§. 33. That the preceding Calculus is not agreeable to Reason, we shall evidence in this Section, and in the following, that it do's not conform with Experience.

First, Because, in Order to prove the Height of the Air is 29042 Feet, it is suppos'd, that the Specifick Gravity of Air to Water, where the Air supports 30 Inches of Quick-silver in the Tube, is as 1 to 850, whereas *Mersennus* has affirm'd it to be as 1 to 1300, Mr. Boyle, as 1 to 938, and the Experiments about London, as 1 to 1000, what the Station of the Mercury was in the Barometer, in the last Observations, it is not necessary to inquire, we shall only take Notice, that the Air, from all these Experiments, may be extremely different, even near the Earth, and that there is no more Reason to exact the Temper of the Air to that which will support 30 Inches of Quick-silver in the Barometer, than any other, when its Proportion of Gravity is compar'd with that of Water; since, if by repeated Trials, Air generally obtains other Proportions than 1 to 850, compar'd with Water, we may as justly ascertain the Properties or Tenour of the Air from thence, as from the Station of the Mercury, at 30 Inches.

Abridgement of Philof. Transf. Vol. 2. p. 16.

Second, From Observations, made by the Incomparable Dr. Halley, it is evident, that, at the Height of 41 Miles, the Air is so rarefy'd as to take up 3000 Times the Space it possesses here, and at 53 Miles high 30000; as therefore the former Experiments that concern'd the Air which was near us,



so these likewise confirm, that the Air in Fact is not Uniform, albeit the present Calculation supposes it.

Third, When the Quick-silver stands at 30 Inches in the Barometer, the Gravity of the Air is computed from that, in respect of Water, or not, if it is, the Mercury in the Tube is suppos'd equal in its Gravitation to that of the Air which sustains it; whereas, by the Experiment of *Hugens*, in which the Quick-silver stands to the Height of 75 Inches, and by all the Accounts which have been given of the Barometer, we shall shew it is absurd to think, that the Station of the Mercury in the Tube is owing to the Gravitation of the Air only, and not to the Action of the Glass, and the Elasticity of the Air, which some Philosophers have acknowledg'd; If it is said, that when the Mercury stands at 30 Inches, the Gravity of Air is not computed from thence, but by other Methods, as the *Æolipile*, &c. it is a Confession, that the Station of Mercury in the Tube is of no Importance to the Gravity of Air, which is determin'd from other ways of Trial; and in general, if the Station of Mercury in the Tube proceeds from Causes distinct from the Air's Gravity, whatever that Station is, it can signify nothing to the affirming the true Proportion of that Gravity or Weight in the Air.

Fourth, Allowing the Air to be Uniform, and that the Computation of its Height is just, upon the last Experiments, which makes it to be 29042 Feet, which, notwithstanding this Calculation, may in reality be 30, 40, or 50 Thousand, or a Million, or more, if, according to Mr. *Halley*, it is not Uniform; we cannot yet but observe, that the second Step in this Computation is again made upon very uncertain Principles, alledg'd in the Problem, to which we are directed; for there the Air is likewise suppos'd to be Uniform, altho'

*Philos. Trans.*  
Vol. 2. p. 23.  
Dr. Wallis  
*Hydrostat.*  
Vol. 1.  
*Rohault Cap.*  
12. Par. 1.  
*Annotat. p. 61.*

Sir Is. Newt.  
*Princip. Prop.*  
49. Prob. 12,  
Lib. 2.

Sir Iſ. Newt.  
Princip. Prop.  
41. Lib. 3.  
p. 503.

this Philosophy, in other parts, tells us, that it has found by Calculation, that the Air, at the Height of one Semidiameter of the Earth, from its Surface, is rarer than that in which we breath, in a much greater Proportion than of the whole Space, which lies beneath the Orb of Saturn, to a Globe only of an Inch Diameter; so easy and ready it is for these Calculators, who assume Principles as they please, to make the Air 29042 Feet High and Uniform, and at other Times, to make it increase in its Rarity, to a Proportion as incredible in one Case, as its uniform Denseness in the other; Besides, in affirming the Uniformity of the Air, it is presum'd, that the Air, which is compress'd by the Incumbent which presses, is of the same Density, which is impossible; for if the Elastick Force, which recoils, is equal to the Pressure, the Air which is compress'd will exert that Elastick Force, which, if the Air that compresses has not, it will not be Uniform, if it has, the Elastick Force, in the compressing Air, oppos'd to the Elastick in the compress'd, will be equal, and destroy each other, and the Incumbent Air left to produce the Effects of its own Gravity; and in such a Case, if the Density of the Air, which is press'd, is the same with that which presses, a Weight of Hundred, or a Million of Pounds, Incumbent upon a Fluid, may as well be said to produce no other Effect, than if it was not Incumbent.

Fifth, Moreover this Problem would induce us to believe, that the Doctrine of Pendulums is necessary to the true Understanding of the Propagation of Sound; We have already sufficiently, as we hope, confuted that pretence, since, according to §. 28. and 29, a Rarefaction and Condensation of the Medium is not prov'd, or if it was, not in that way which is suppos'd, and thought to be agreeable to the Oscillations of a Pendulum, namely, by the Progress and Returns of each distinct Portion of Air, which

which propagates the Sound, and not by one Uniform Condensation and Rarefaction of the Whole.

Sixth, It is suppos'd that the Length of one Pendulum, from whence this Computation is made, is that of the whole Height of the Air, namely 29042 Feet, or 348500 Inches, and of the other 39½. If therefore Pendulums of such Lengths are apply'd to the Oscillations of the Air, it must be presum'd that the Air, if it were to Oscillate in either Cases, would first oscillate in the same Lengths, which is impossible; and second would describe its Progress and Returns in the same time, as a common Pendulum do's, which as much wants a Demonstration, as that the String of a Harp, or a Virginal, when struck, observes the same Laws with those of a Pendulous Body, or that the Quick and Elastick Force of a stretch'd Wire is analogous to the Motion of a Flat and Heavy Substance; for the Elastick Force of the Air may be as different in the Effects it obtains upon Impulse, from those which common Matter swinging in a Pendulum receives from Impulse, as common Matter, or Lead, for Instance, is different from Air it self; and indeed it not only may be so, but really is so, unless Impulse will produce the same Effects upon a Body which is Elastick, and which is Heavy; which, as it is impossible, so likewise the Modern Philosophy, in its Doctrine of Elasticity, do's in Terms disclaim.

§. 34. Farther, Granting the Computation to be true, this Calculus determines the Propagation of Sound to a certain and fixt Number, that is, 968, whereas in Reason, and Experiment, the Propagation of it is various; in Fact it is manifestly so, since some Experiments assert 600 Feet, others 1474, and a third sort betwixt 920 and 1085; nor can it be said, that, in reality, one is more accurate and exact than the other, since they ought to be different, if different Bodies are made use of in the several Experiments, which we shall afterwards consider; how-

*If the Calculation was just, it is not confirm'd by Experiment. nor is agreeable to Reason.*



however it be, there is a plain Disagreement in these Observations, the cause of which we do not at present inquire; and to imagine that one Observer was more cautious than another, is making Philosophy depend upon the Authority of Names, and not on the Reality of things.

More than this, supposing all other Experiments, excepting the last, were not justly made, and that the Propagation of Sound is more than 920 Feet, and less than 1085, to determine it to 968, the Number found out, by the present Calculus, is something extraordinary; since it is only one Number of 165, which lies betwixt 920 and 1085, so that Sound may be propagated, by these Experiments, almost 120 Feet distant from the place, which is fixt by Computation, and yet shall be thought to agree with it; but, if this was a strict and Geometrick Demonstration, and the Experiments are granted to be accurate and true, how comes it to pass that the one should not correspond with the other, within an Inch, a Foot, 10 Foot, or at the least 40 or 50, allowing the utmost to the Casualties of Observation, or the Infirmities of Reason? And yet here is above 100 Foot to be accounted for, which is look'd upon, I presume, as one of the Minutiæ in Philosophy, as there are several in Astronomy, and the present Mathematicks of Fluxions and the infinite Series, which are thought fit to be despis'd, tho', as we shall afterwards prove, they have a real place in Nature.

*The Propagation of Sound ought in Reason to be various, and therefore cannot be exacted to one certain Computation.*

§. 35. Lastly, granting the Computation to be true, it is certain that there cannot be any fixt and determin'd Propagation of Sound, so as to be express'd by one particular Number, whether it is that of 968 Feet, or any other, seeing this Calculation is only made upon one Hypothesis of Pendulums, which is not answerable to the variety of Sounds; for if one Bell, for instance, which has a grave Sound, and according to this Philosophy, a slower Motion, propagates its Effect to one cer-  
tain



tain Distance, that which has a quicker and more lively will not make the very same Impressions upon the Medium, much less will the Sound of a Drum, the same with that of a Canon, or that of a Violin, with the other of a Hautboy; not to mention the Difference in the Experiments before alludg'd, where in one Case Sound is propagated to double the Distance of what it is in another, one only affirming 600 Feet, and another above 1400, which in all probability depends upon the Difference of the Sonorous Bodies, and the Medium in which such Experiments were made, or on the Strength and Force of the Powder us'd in the Explosion.

§. 36. Next to the Computation of the Velocity of Sound, the Diminution of it, in an exhausted Receiver, is here consider'd, which apparently languishes, as the included Medium grows thinner; but according to this Philosophy, in its Doctrine of the Propagation of Pulses, if we could hear Sound at 10 Times the Distance from the

*The Difference of Sounds in Mediums of a different Density, not solv'd by the Proportion assign'd in this Doctrine.*

Receiver, in the same Force and Degree, as when the Receiver is exhausted to a hundredth part of its Air, its Reasonings would exactly correspond to what would be experienc'd in Nature, since this Philosophy supposes, that the Sound of an equally Sonorous Body is in its Distance in a dimidiate Proportion of the Densities of Air; on the other hand therefore, if this is not true in Experiment, it cannot be so in any Theory, which is meant to explain the Affections and Properties of Nature; and consequently the Principles on which it depends must be evidently wrong, and without any Foundation in a real Knowledge of Things.

Sir H. Newt. Princip. Prop. 50. Lib. 2. P. 371, 372.

§. 37. For, if we inject one Atmosphere into the Receiver, the Sound, which was heard in common Air only 30 Yards, will reach 60, if a second, 90, and afterwards, tho' a Hundred Strokes of the Forcer were repeated, yet it could not be made to extend

*Prov'd from Experiments. Mr. Hawksbee's Experiments, p. 97, 98, &c.*

extend above 20 Yards farther, which is a plain and manifest Proof, that the Distance of Sound is not in a dimidiated Proportion of the Density of the Mediums, thro' which it is convey'd.

*The Intervals of the Pulses, not accounted for from the Velocity of Sounds given.*

Sir Iſ. Newt.

Princ. Prop. 50.

Lib. 2. P. 372.

§. 38. Another Experiment, which is propos'd in this Doctrine, is, that a String, which has such a Tension, as to be equal in its Note to *C Fa-ut*, upon the Organ, being a Pipe of four foot long, will return 104 times in the 60<sup>th</sup> part of a Minute; from whence it will follow, that there will be 104 Pulses in the space of 968 feet, or 1 Pulse in 9 feet and a quarter, and therefore it is thought to be not unlikely, that the Latitude or Extent of the Pulses, in the Sounds of the said Pipe in the Organ, are double the Lengths of their Pipes and consequently the Velocity of Sounds being known, namely, that they describe 968 feet in a 2<sup>d</sup> of Time, by this Method the Latitude or Reach, which Sounds take in their Swings, will be determin'd. But this is no Proof of the preceding Principles, and is only a Deduction from them, which again likewise seems incredible in the Nature of Things: for who can either imagine that the Pulse of a String, which is suppos'd to have a good Degree of Tension, should oscillate in a swing of 9 feet and a quarter, to produce one determinate Sound, or that it must be so in the Vibrations of the Air, communicated from the Organ; if it is done by one Oscillation, in the first Case, to which the other is made parallel, it is contrary to plain Sense; if it is done by several, what is it which makes the Distinction betwixt the Aggregates of the Vibrations in the first Pulse, from those in the second? or how is it possible, that a Repetition of them should perform the Effect, requir'd, of Sound, if it is own'd that singly none of them can do it?

*Why Sounds immediately cease at a greater Distance, as*

§. 39. It is farther alledg'd, from Matter of Fact, that Sounds are lost, and vanish in the very Moment that the Sonorous Body becomes quiescent,

scnt, tho' we should be at the greatest Distance, *well as a less,*  
 as well as if we were at the nearest remove from it; *from the Sono-*  
 which is said to be confirm'd from what naturally *rous Body, not so*  
 arises, and may be rationally deduc'd from these *well explain'd*  
 Principles; the number of Pulses, which are pro- *upon this Hypo-*  
 pagated, being the same with the number of the *thesis, as the*  
 Vibrations of the Tremulous Body; for as soon *contrary.*  
 as any one of 'em returns to the place from which  
 it was impell'd, it will continue there, till it is  
 forc'd from thence by a new Effort of it, or the  
 Pulses which are propagated from it: But first, it  
 will be hard to imagine, if the Medium consists of  
 Distinct Pulses or Pendulums, how there should be  
 such a close Harmony betwixt so many separate  
 Oscillations, as upon the ceasing of the first, all  
 the rest should lose their Vibrations; unless, Se-  
 condly, these separate Pulses are at length resolv'd  
 into one uniform Pulse, thro' the whole Medium,  
 according to the Explanation §. 28, Arg. 7, or if  
 they are not, since that uniform Pulse and Re-pulse,  
 thro' the whole Medium, will much better satisfy  
 the present Phænomenon, a Solution of it cannot  
 be a Confirmation of the foregoing Hypothesis of  
 several distinct Pendulums in the Air, seeing it may,  
 at least, as justly be explicated upon another.

Sir Is. Newt.  
 Princip. Prop.  
 50. Lib. 2. p.  
 372. & Prop.  
 48. Lib. 2.

§. 40. Moreover, by these Separate and Distinct  
 Pulses of the Medium, the Sounds which are aug-  
 mented by the Tubes, contriv'd for that pur-  
 pose, are thought to be explain'd, since upon eve-  
 ry Result of the Pulse, to the Cause which pro-  
 duces it, the Motion is increas'd, and the Pulses  
 being hindred from dilating themselves, strike  
 upon the sides of the Tube, and receive a new  
 Force from the Sonorous Body, by which Means  
 the Sound becomes more full. This Explana-  
 tion do's not agree with the former in §. 39;  
 for there it is suppos'd, that the Pulse, upon eve-  
 ry Recourse or Result, is quiescent, till a fresh  
 Force excites it, and here, that it retains a cer-  
 tain

*The Phænome-*  
*nons of the*  
*Speaking*  
*Trumpet unac-*  
*counted for.*  
 Sir Is. Newt.  
 Princip. p. 372.



tain Motion, which is increas'd by the Addition of a new. Besides which, there would be such a Confusion here of the little Moving Pendulums, from all the sides of the Sonorous Bodies, that they would clash and interfere with each other, to that degree that the Calculation beforemention'd, of the Velocity of Sound, would infallibly be destroy'd, and it would be hard to conceive how there should be any Propagation of it at all.

Sturmius's  
Colleg. Curios.

Lastly, it is known, that Pastboard, if made into such a Sonorous Instrument, will have nearly the same Effects with one of Copper, and yet the Vibrations of the one will be acknowledg'd to be very different from those of the other; and therefore must create a wide Distinction betwixt the Pulses of the same Medium, tho the Greatness of the Sound is much alike in both Cases.

*The Propagation of Sound, thro' a hard and consistent Body impossible, upon these Principles.*

§. 41. To conclude, if these Pulses were acknowledg'd in the Air, and the Rarefactions and Condensations consequent upon them, this could not give any Account how Sound was propagated thro' hard and consistent Bodies, which they evidently are; for if we strike a piece of Timber at one end, and lay our Ear to the other, the Sound is impress'd very audibly upon it; but where a Doctrine in general is propos'd, concerning the Propagation of Sound, it ought to be form'd upon such Universal Principles, as may be extended to all the Phænomenons of that kind.

*The remaining Propositions of this Philosophy recited, and why not particularly consider'd?*

Sir Is. Newt.  
Princip. Prop.  
47, 48, 49.  
Lib. 2.

§. 42. The Propositions in this Doctrine which remain, and which we have not particularly examin'd, are, First, that the Velocities of the Pulses, propagated in an Elastick Fluid, are in a Reason compounded of the Dimidiate Reason of the Elastick Force directly, and the Dimidiate Reason of the Density inversely, upon this Supposition, that the Elastick Force of the same Fluid is proportional to its Condensation. Secondly, That Pulses being propagated thro' a Fluid, each of the Particles of the Fluid



Fluid oscillate, and are accelerated and retarded, according to the Laws of the Pendulum. Third, The Density and Elastick Force of the Medium being given, to find the Velocity of the Pulses. But 1<sup>st</sup>, since all these depend upon the Doctrine of Pulses, and only concern the Proportion of their Velocities, in respect of the Denseness of the Medium, and the Elasticity of it, they are only abstracted Reasonings upon false and groundless Hypotheses, if there are no such Pulses, as we have endeavour'd to prove there are not. 2<sup>d</sup>, They are chiefly alledg'd to evince the Velocity of Sound, by Calculation, agreeable to what is found by Experience, which they do not do. 3<sup>d</sup>, They depend upon a new Supposition, which is not true, that the Elastick Force of a Medium is proportional to its Condensation; since Elasticity, in general, ought to be measur'd by its own Force, and not by an External that compresses, and which therefore may be sometimes superior to the Compression, and sometimes inferior to it, as we shall afterwards shew.

§. 43. To finish this Head of Sounds, and the Propagation of them; the Reason why these Imaginary Pulses are introduc'd to explain Sound, seems to be, that this Philosophy had just before been considering the Laws of Pendulums, and had been taken up with several Experiments concerning their various Oscillations, which had given such an Impression to it, that the whole *Æther* immediately form'd it self into so many little moving Pendulums, and began to play and swing about with as much Regularity and Order, and with as just a Harmony as if there had been something more than Fancy in it: Thus if any one has been looking very intently, for some considerable time, upon any Brisk and Vivid Colour, and he makes his Eye pass to other Objects, they will all appear of the same Complexion, and make him believe, if Caution is not us'd, that there is something real in what he sees.

*The Rise and Original, as we may justly imagine, of this way of Reasoning upon Sounds.*

Sir Is. Newt. Princ. Prop. 40. Lib. 2. Schol. General.

## C H A P. II.

## Concerning Light and Colours, according to the Cartesian Account of them.

*The Cartesian  
Philosophy of  
Light and Co-  
lours inferiour  
to the Modern.  
Sir If Newt.  
Opticks.  
Rohault Cap.  
27. Par. 1.  
Cartes Princ.*

§. 1. **T**He last Thing we shall think it necessary to contradict, in the Philosophy of Similar and Homogeneous Matter, is, its Account of Light and Colours, which is so extremely absurd, that I am apt to believe there is not any one who will defend it in the present Age, in which the Degrees of Refrangibility in the Rays of Light, original to their Refraction, are experimentally prov'd, as it is thought, to occasion those various Sensations of Colour in us; for after so Rational an Hypothesis, which it is presum'd to be, who can ever imagine little Globes of Matter arbitrarily contriv'd, and revolv'd into sundry Determinations of Motion, to be the Cause of our Perceptions of Colours? Or that a Rectitude of Pores in Glass or Water is necessary to produce a Transparency, when, according to that Notion, an Omni-transparent Body ought to be Omni-porous, and consequently nothing else but Vacuity? However, we shall make some few Observations upon the Old Philosophy of Light and Colours, and from thence proceed to the New.

*The Definition  
of Primigenial  
and Secondary  
Light in the  
Corpuscular  
Account.*

*Rohault Cap.  
27. §. 15.  
Par. 1.*

§. 2. As to Light, the Primigenial is said to consist in the Internal Motion of the parts of the Luminous Body, and the Secondary in a Disposition in the Matter which surrounds it, to recede in a straight Line from the Action of the Lucid Point. This Action therefore of the Primigenial Light is principally to be consider'd, since the other of the Secondary depends upon and results from it.

§. 3. A

§. 3. Against which we have this to object, that the Internal Motion of the parts is not an adequate Cause of such an Effect, there being Light produc'd from several Bodies, where it is not likely, or at least, is not prov'd, that there is any Motion; as in rotten Wood, putrify'd Fish, a polish'd Diamond, &c. and from others, where it is not necessary to suppose any Internal Motion, as in Fire, or even in Flame it self, which, by what has been discours'd above concerning Heat, is not evidenc'd to be under an unavoidable Agitation of its parts, so far as it produces Heat, and we may here add Light too.

*The foregoing Account of Light not prov'd.*

§. 4. On the other hand, the first Author and Founder of this Philosophy, gives a quite different Account of the Light propagated from certain Bodies, which shews the Inconsistency of it, whilst it endeavours to contrive another Solution for such kind of Phænomenons, as those of rotten Wood and putrify'd Fish, by assigning the Cause of their Light to a Contraction of their Pores, in their being dry'd, from whence it comes to pass, that they are capable of admitting only the finest parts of the Second Element.

*Contradicted by Cartes himself. Cartes. Princ. par. 4. §. 91.*

§. 5. But that which makes this Doctrine more Unreasonable, is, the Introducing those Imaginary Globuli of the Second Element, (and taking them for granted,) which we have already confuted, and asserting a Plenum upon a Similar and Homogeneous Matter acknowledg'd, which is altogether impossible, for if there was not such a Plenum, all that is said concerning the Propagation of Light, in an instant, would remain unprov'd.

*The Doctrine of the Globuli of the Second Element, and the Cartesian Plenum necessary to a Solution of Light and its Propagation in an instant, and therefore the whole*

*unreasonable. Rohault Cap. 27. §. 30, 31, 32, &c. Par. 1.*

§. 6. Besides, as to the propagation of Light, it is evident, from the Observations of Astronomers, that Light is not propagated from the Sun in an instant, but spends seven or eight Minutes in its progress from thence

*The Propagation of Light in an instant, disprov'd from the Eclipses of Ju-*



*Jupiter's Satel-  
lites.*

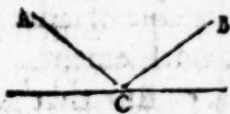
Sir Iſ. Newt.  
Opticks Prop.  
11. Part. 3.  
Book 2. p. 77.

thence to the Earth, if the following Reasoning is true; since, when the Earth is on the same side of the Sun with *Jupiter*, the Eclipses of the Satellites are observ'd 7 or 8 Minutes sooner than they are determin'd by Calculation; and when on the contrary side, 7 or 8 Minutes later, the reason of which Difference is affirm'd to be only this, That the Light reflected from the Satellites, in the last Case, go's a whole Diameter of the Earth's Orbit farther than in the former, and consequently the Appearances observable in these Satellites must come later to our Notice. That it cannot proceed from any Irregularities in the Motions of the Planet, or the Satellites of it, is accounted evident, because, altho' *Jupiter* and his Satellites are accelerated in their Descent to their Perihelium, and retarded in their Ascent to their Aphelium, yet in all parts of their Revolutions round the Sun, this Difference is only known in that certain position of the Earth's Conjunction and Opposition with them.

*The Reflections  
of Light not  
sol'd by this  
Philosophy.*  
Rohault Cap.  
27. §. 35. Par. 1.

§. 7. Another Objection which lies against this Account of Light, is, that it cannot solve the Reflections of it; for seeing the

Ray *AC* has no actual Motion, nor no resilient Force, which is explain'd, and there is only a flat



Pressure in Light from *A* to *C*, the Pressure would be determin'd at *C*, without any Reflection at all to *B*, Light being only consider'd as an inflexible Line, in which Pressure is propagated from one end of it to the other.

*The Absurdity  
of this Doctrine  
evident, from  
an Instance of  
Black Marble.*  
Rohault Cap.  
27. §. 36. 61.  
62.

§. 8. Farther, the more solid any Body is, according to the present Doctrine, and the fewer Vacuities or Pores there are in it, the more Rays it ought to reflect, on the contrary, according to the same Philosophy, the blacker any Body is, the more Rays it absorbs, and the fewer are reflected from it; and therefore Black Marble, if such a Reasoning is true, will reflect the most and the fewest Rays



Rays of any Body whatsoever, which is a Contradiction in Terms.

§. 9. Lastly, as to what concerns Reflections, *Evident like- the more obliquely any Rays fall upon a transpa- wise from a* rent Medium, as Glass or Water, this Philosophy *Comparison* reaches, they will upon that account meet with *with what it* more solid parts to reflect them, and yet at the *teaches con- cerning Transa-* same time affirms, that a Transparent Body has *parent Bodies.* Rectilineal Pores every way, by which Light is *Rohault Cap.* transmitted, and therefore that there are no more *27. §. 36. 88* solid parts one way than another, which likewise *§. 15. Par. 1.* are Assertions, that are not to be reconcil'd.

§. 10. And as this Doctrine gives no Solution of *The Refractions of Light how* the Reflections of Light, so neither do's it of the *explain'd in this Philosophy.* Refractions of it. For it tells us, that different *Rohault Cap.* Refractions proceed from Light's being more easily *27. §. 38. Par. 1.* transmitted thro' one Medium than another, and that it is refracted towards the Perpendicular in its passage from Air to Glass; that is, is more easily transmitted thro' Glass than Air, because the parts of the Glass being at rest, do not give the same Interruption to the Progress of Light, as Air do's.

§. 11. To which it is answer'd, Either Light, *A Confutation of the preceding Account.* in its Refraction, passes through the direct Pores *Rohault Cap.* of the Glass, or thro' the parts of it; if the first, *27. §. 38. Par. 1.* there could be no Refraction, since Light would meet with nothing to resist it; if the last, it is necessary to think, there must be a much greater Difficulty to surmount the solid and resisting parts of Glass, than the more pliant and yielding ones of Air; whatever Ingenious Comparisons may be brought to convince us of the contrary, by Bowls, as the Globuli of Light are suppos'd a sort of ones, being more entangl'd and hamper'd in their Motion thro' Grass, than upon a hard and even Plain.

§. 12. What yet embarrasses this Philosophy *The Irregular Motion in Heat, and the Direct Pressure in* is, that having before asserted, that Heat *Light, both* consists in a confus'd and irregular Motion of parts, and that Light do's in a direct and instantaneous *pressure*

*which this Philosophy affirms, inconsistent.*

*Robault Cap.*

*27. §. 48. Par. 1.*

*compar'd with*

*§. 30, 31, 32,*

*&c. and Cap.*

*23. §. 10, &c.*

*Par. 1.*

Pressure of them, and not being able to deny Light and Heat to exist together in the same Rays, it is oblig'd to affirm a direct Pressure, or a Conatus to Motion, to be a confus'd and irregular Motion, compar'd with which is really impossible: This, however, is endeavour'd to be solv'd from some accidental Causes, namely, the unequal Parts of Light, and the unequal Resistance they meet with from the Matter that surrounds them, whereas before it had inform'd us, that the Globes were alike, and that the Rays could not recede from a direct Pressure, because they were equally supported on all hands from the Ambient Fluid, that is, because they met every where with an equal Resistance, upon which Account they were compar'd to Columns of Water, which propagated their Pressure in the same way; so easy is it, for this Philosophy, to forget what it had in abundance of Instances advanc'd but a few Paragraphs before.

*Of Colours in general, and the Causes of Objects appearing white or black.*

*Robault Cap.*

*27. §. 53, 54,*

*57.*

§. 13. The next thing, after Light, is Colours, which are said to consist in Light's being reflected every way from the colour'd Body, by a certain roughness spread upon the surface of it, by which means White is produc'd, from an absolute Reflection of the whole Light to all sides, and Black from the smalness of the Parts of the Body, and their being disjoyn'd, and separated from each other, so that they become easy and yielding to the Impulses of Light, which therefore entering is absorpt and detain'd in its Substance, without being reflected from it to the Eye.

*That White do's not consist in reflecting Light, as it fell, on two Accounts.*

*Robault Cap.*

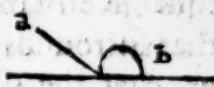
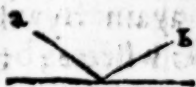
*27. §. 54.*

§. 14. In answer to the first, If all the Rays of Light, which are incident on a Body, are reflected with the same Force, and as entire as they fell, Light would not be different from Whiteness, whereas it apparently is; neither would it be any Modification of Light at all, which this Philosophy affirms, tho' it owns it to be the least that can be, since it would be Light it self, without any

Modi-

Modification: Besides, in a rough surface, how all the Light, which is incident, should be reflected on every hand, with the same Strength and Vivacity, with which it fell, is impossible to comprehend; for since, in a plain Surface, it is acknowledged to be inconceivable, the Asperities will be so far from assist-

ing such a diffusive Reflection, that, in the first, the Rays



from *a* would be reflected to the Eye in *b*, and, in the last, would not arrive at the Eye at all.

§. 15. Nor do's the Example brought to prove this Doctrine, that Sand which is white, if view'd thro' a Microscope, appears transparent, any ways confirm it; because it is no more certain, that a Congeries of transparent Bodies, producing in us the Sensation of Whiteness, should therefore owe their Whiteness to a Determin'd Asperity, in the surface of the reflecting Body, than that they should to the united Force of such distinct transparencies; for since it is observ'd, by the same Microscopes, in the Blood, that its parts consist of little red Globes, swimming in a transparent Liquor, which Liquor, as well as the Globes, appear together of an Intense Red, it will be hard to say, Why several transparent Substances, amass'd into one, may not appear of an Intense White, without having recourse to the Roughness of the Surface, which reflects; several Bodies likewise, when view'd thro' a Microscope, appear transparent, which yet are not of a white Colour, when view'd without it.

*That White depends upon the Asperity of the Reflecting Body, not confirm'd from white Sand, view'd thro' a Microscope.*  
Arg. 1.

§. 16. Besides, Bodies of all Colours are by some

of the most Celebrated Philosophers, and even in this Philosophy it self, asserted to consist ultimately of little transparent Parts; if therefore this Argument were a just one, it would follow, that the Congeries of Transparent Parts, which pro-

*From Bodies of all Colours being thought to be resolv'd into Transparent Parts.*  
Arg. 2.



Sir I. Newt. *Optick*. Prop. 5. Part 3. Book 2. p. 55. duce a Blue or a Yellow, should produce a White, namely, because they are transparent, and are thrown together into one Heap, or Congeries.

Robault Cap. 27. §. 69. Par. 1. \* §. 17. The second Example, is, That Silver, after its Trial in the Fire is reduc'd by the Gold-

*\* Not confirm'd from the Experiment upon Silver which loses its whiteness by the Fire, and regains it by a decoction of Tartar.* smith's to its Whiteness, by a Corroding Liquor, as the Decoction of Tartar, and common Salt, and loses its Whiteness again by the Friction of the Hæmatites, or Blood-stone; but it is something wonderful that Fire, which is, and must be own'd, as corroding as the Decoction of Tartar and common Salt, should introduce one Colour upon it, and the Decoction a different; or that the Hæmatites should deprive it of its Whiteness, when all other Polishes improve it, unless there were some particular Properties, or occult Qualities in them, which want to be explain'd.

Robault Cap. 27. §. 55. §. 18. Lastly, we are yet to seek, wherefore White being seen in every position of the Eye should be a Reason for the truth of this Hypothesis, since the Colours of other Bodies are so too; and in reflecting Glasses, where Light is intirely return'd from them in one situation, at least, of the Eye, yet White is seen in none, unless Brightness, or the Vivid Action of the Rays, which rebound from thence, are the same, as the Whiteness of the Paper we write on.

*Not confirm'd from Whiteness being seen in all Directions.* Cap. 27. §. 56. §. 19. In answer to the Account given us of what the Nature of Black is; First, it is no Argument that it consists in the Smalness of the Parts of the Body, which is endued with that Quality, and Disunion of them, by which they more readily admit the Rays which are incident, because Black is contrary to White; since then it would be more Natural to think, that as White is a Modification of Light from a Rough Surface, so Black should be one of it from a Smooth.

*The Nature of Blackness not determin'd by its being opposite to White.* Cap. 27. §. 57.



§. 20. Secondly, Neither is it a Proof of this Hypothesis of Small Parts, and large Pores being requisite to Blackness, because in White the Rays are suppos'd to be reflected, and in Black not; since for all that is yet evinc'd, the Rays may by some Methods or other be not reflected, without presuming an Actual Ingress of them into the Substance on which they fall; thus a Marble may rebound from a Stone, but when dropt on Lead, or on Clay, may not do it, tho' at the same time no one, to solve this Non-resiliency, ever dream'd of its being lost and intangl'd in the Parts of either; that is, it is not sufficiently evidenc'd in this Philosophy, that if Black consists in the Interception of the Rays, there is no other way of their being intercepted, than by their Extinction in the Body it self.

§. 21. Thirdly, If the Rays were extinguish'd in the Substance, it is not necessary that that should be effected by the Smalness of its Parts, and the Largeness of its Pores, no more than a Stone, thrown into the Water, should lose its Motion the same way, which no one will be forward, I believe, to acknowledge; since the Pores of the Water, as well as the Parts, are extremely small, and yet Motion is extinguish'd without any such necessity of large Pores and small Parts; and why it may not be so in the Actions betwixt Light and Body, as well as a Projectile and Water, we are to be inform'd.

§. 22. Fourthly, From whence it will follow, that the Instances alledg'd are likewise as incompetent to prove this Doctrine, as the Reasons made use of to perswade us of the truth of it. For, first, Tho' Wood becomes Black by the Action of the Fire, as in Charcoal, that the Parts of it after the Action of the Fire upon it, which remain, should be more susceptible of any Motion, as of Light, which is impress'd, so as to yield to it, is not to be imagin'd; it is more reasonable to affirm, whilst Bodies are suppos'd to consist of Heterogeneous Particles, that the lighter

*Not explain'd, tho' the Rays of a white Body should be suppos'd to be reflected, and those of a black, not.*

*Not explain'd, tho' the Rays of a black Body should be suppos'd to be extinguish'd in its substance,*

*The Instance of Charcoal, which turns black by the Action of the Fire, confuted. Cap. 27. §. 59. 60.*

and more agile are thrown off by the Fire, and that the more solid and pertinacious are left behind, which as they resisted the violence of the Fire, cannot but be suppos'd to retain an equal, or rather a greater obstinacy against the Rays of the Sun; besides it is own'd, that a white kind of Ashes is observable upon the Coal, which it is impossible to conceive should have more solid and resisting, or reflecting parts, than those of the Coal it self, since the former is easily made to move by a breath only, when the latter scarcely submits to a much greater Impression.

*The Instance of black Bodies, being lighter than white, confuted.*

Cap. 27. §. 61.

§. 23. Farther, As this Philosophy supposes a Minuteness of parts, and an Interval betwixt them necessary to produce Black, it is consequent to it to affirm, that in black Bodies there is a less portion of Matter than in white; and therefore since Gravity, in the present Doctrine of Homogeneous Matter, is proportional to the Quantity of it contain'd in any Substance, black Bodies ought to be lighter than white ones, or any other; in order to evince which, the Coal is said to be lighter than the Wood, from which it is made, and black Marble than white; but as there are 100 Instances where black Bodies are heavier than white, as Marble, or Jet, &c. than Wool, or a Feather, so it is wisely subjoyn'd in this Philosophy, that all things else must be equal, whereas in black and white Marble, or in Wood and Charcoal, all things else, are not prov'd to be equal; notwithstanding which Caution, it is not manifest, that Bodies are light or heavy, according as they have greater Pores, and less parts, or the contrary, unless upon the Hypothesis of Similar and Homogeneous Matter; the truth of which Hypothesis we have good reason, as has been shewn, to deny.

*The preceding Instance not valid, unless this Philosophy will affirm black to be white, and white black.*

§. 24 Besides, in this Philosophy all things else are equal, excepting the parts and Pores of Bodies, in which only they differ; if therefore black and white are distinguish'd from each other, by the peculiar Pores

Pores and Parts of those Substances, it will be necessary that black Bodies, in general, should be lighter than white; for if there is any Case where it is not so, the black must have more parts, and fewer Pores than the white Body, which is the very Account given us of Whiteness; that is, black will be white, and white black by such a way of Reasoning.

§. 25. It is moreover said, that black Bodies are sooner set on Fire, by a Lens collecting the Rays of the Sun, than white ones are; but that this is no Argument is evident, because Fire is more easily reviv'd in Cinders, which are white or graish, than excited in Coals, which are black, and Paper, tho' white, immediately burns, if held in the Focus, when a black piece of Flint perceives not the least Effect from all its Violence; if other things are here again suppos'd to be equal, such an Exception admits of the same Answer as before.

*The Instance of black Bodies being more inflammable than others, confutes, as it relates to the present Doctrine.*  
Cap. 27. §. 62.

§. 26. Lastly, whereas we are told that white Bodies tire and fatigue the Sight, when black ones cherish and refresh it, and that therefore the Rays of Light are extinguish'd in the one, and reflected from the other; this neither is no Argument what Way, or by what Methods the Rays of Light are extinguish'd, or intercepted; because the most it proves, is only that they are intercepted, which can never be drawn into an Inference of their being intercepted in any particular manner; much less by the Minuteness of the parts of a Body, and the Largeness or Multiplicity of its Pores.

*The Instance of black Bodies being less offensive to the Eyes than white, as it respects this Philosophy confuted.*  
Cap. 27. §. 63.

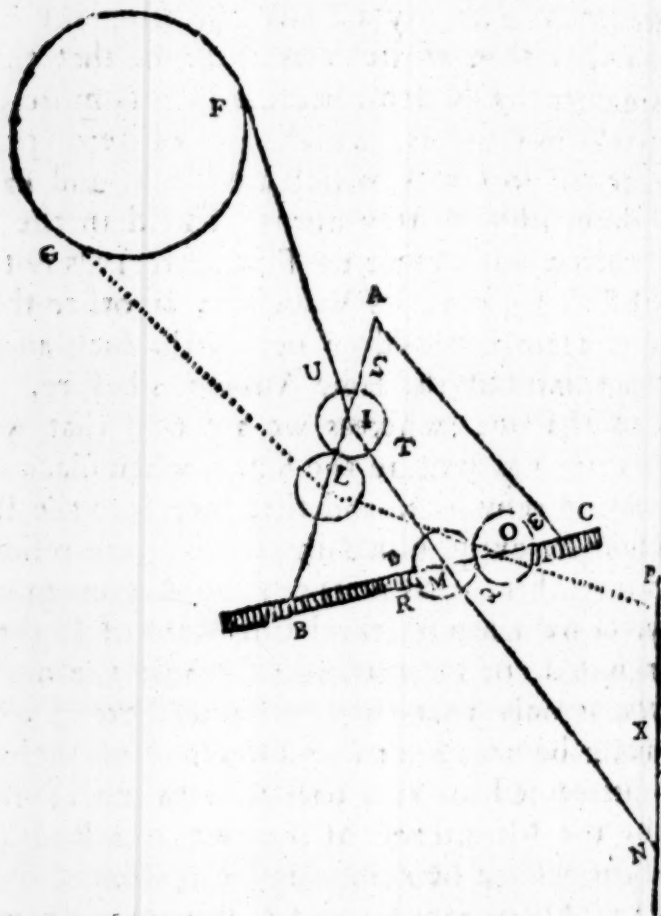
§. 27. As to other sorts of Colours besides white and black, which are made by the Refractions of Light thro' a Prism, the Account of them is this.

*The Refractions of Light thro' a Prism, and the Colours produced therefrom, how accounted for in this Philosophy.*  
Rohault Cap. 27. §. 65, 66, 67, 68.

That supposing the Rays pass in little Globes from *F* to *I*, and *G* to *L* in a direct Motion, *I* meeting with a greater resistance in *AB* towards *B* than *S*, it is made to revolve in the direction of *STU*, and so proceeds to *M*, and the same may be said of the Globe *L* in its progress to *O*, but when



when the Globe *I* arrives at *M*, meeting from the Shadow there, namely *DR*, with a fresh resistance towards the same side, the Velocity of its revolution is farther increas'd the same way, with which increas'd Velocity it proceeds to *N*; on the other hand the Globe *L* is revolv'd from *S* to *T* and *U*, but when it arrives at *O*, its revolution meets with



a contrary Direction, and therefore go's on to *P*, with a more direct and a less Vertiginous Motion, from whence it is concluded, that since Red is seen at *N*, and Cærulean or Purple at *P*, that Red consists in the Globes of Light, having a quicker Vertiginous Motion than a direct, and Purple in having a quicker Direct than a Vertiginous, and that therefore those that fall on *X*, are temper'd in their Motion



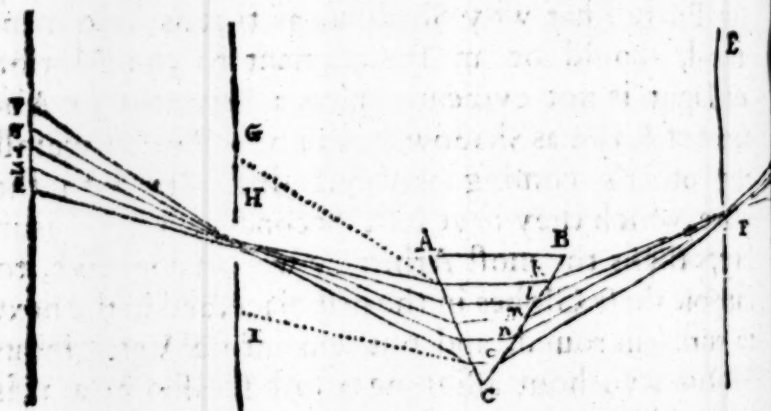
Motion betwixt both, in which Yellow consists, that Colour being observable there; from whence may be determin'd, as it is thought, into what kind of Motion Orange or Gold Colour, which appears betwixt *X* and *N*, and Green which lyes betwixt *X* and *P* may be resolv'd, namely, Green is suppos'd to approach nearer to a Direct than a Vertiginous, and Orange, on the contrary, more to a Vertiginous than a Direct.

§. 28. The truth of it is, this Account, at the first View, is so apparently absurd, that it scarcely deserves a Confutation. We shall therefore only say, First, That why Shadow, as that is here mention'd, should be an Impediment to the Motion of Light is not evident, unless a Privation or Absence of Rays, as Shadow is, can be a Reason against any other's coming without difficulty into the place, which they have left. Secondly, That it is an Hypothesis the most Arbitrary we can conceive, to suppose these Globes in the first place, and in the next to turn 'em round, and put 'em into a Vertiginous Motion, without assigning a just Reason how it is produc'd; for if the Globe *I* in its Descent from *F* meets with a resistance in the Line *AB* towards *B*, it would either be reflected towards *AC*, or after the first shock, by which *S* would be revolv'd to *T*, for Instance, proceed forwards in a direct Motion to *M*. Thirdly, That allowing shadow could resist, and the Globe be thrown round upon its Axis, it would be altogether impossible to explain the Colours of Bodies in the same manner, which yet ought to be done, since Effects, which are alike, are unwarily solv'd, where we take the Latitude to assign them to different Causes. Fourthly, If a Circular or Vertiginous Motion produces Colours different from Light, Light by this Philosophy ought to produce Colours different from it self, since not only a Direct but a Circular Motion is suppos'd to be in it, in order to produce

*The Absurdity and Precariousness of this Hypothesis shewn upon several Accounts.*

Sir Is. Newt.  
Opticks Prop.  
1. Part. 2.  
Book 1.

duce Heat. Lastly, There are several Experiments which prove, that Colours, produc'd by the refraction of Light thro' a Prism, do not depend on the various Terminations of Light and Shadow, one of which is, that if a Beam of the *Sun's* Light falls thro' the Foramen *F*, and is refracted thro' a large Prism *ACB*, plac'd at 20 foot distance from it, and parallel to *EF*, and is again with its white part transmitted thro' another Foramen *H*, in a black Body *GI*, and made to paint upon *pt* the several Colours, as Red at *t*, Yellow at *s*, Green at *r*,



Blue at *q*, and Violet at *p*, intercept the Rays at *k, l, m, n, o*, by any Iron Wire, or any other opaque Body, and the Rays at *t, s, r, q, p* will disappear, whilst the other Colours remain; from whence it is manifest, that the Shadow, made by the Wire, causes no Alteration in the colour'd Rays in *pt*, since they continue the same, however, the Rays in *ko* are hinder'd in their Progress, and consequently Red, Yellow, Green, Blue or Violet, will preserve their Colour, whether they border upon Shadow or not, which therefore can have no Influence in producing them.

*The Colours of  
Natural Bodies  
not capable of  
being explain'd  
upon the afore-*

§. 29. This Hypothesis as unwarrantable and incredible as it is, is yet apply'd to the Explaining of the Colours of Natural Bodies, which are suppos'd to consist of infinitely small and transparent parts,

parts, and by that means to refract the Light, and impress upon its Globes a Circular Motion; thus Sand, Flint, Marble, Sugar, Silk, Wool, Hair, Herbs, and several other Bodies thro' a Microscope, seem to be colourless and translucent.

*mention'd Hy-  
pothesis.  
Rohault Cap.  
27. §. 69. Par. 1.*

But if this were granted, it must still farther be affirm'd, that where-ever Light is refracted, be the transparent parts of what Figure they will, its Globes will be revolv'd in a Vertiginous Motion, and consequently some Colour or other induc'd upon the Rays of Light in every refraction, which is contrary to Experience; if it is not affirm'd, the parts of Natural Bodies must be exactly correspondent to the Figure of the Prism, and the Incidence of the Rays and the Refraction the same, which is deny'd in this Philosophy in the very Supposition of their being reflected, since none of the colour'd Rays are so in the Prism.

Besides, in the Prism all sorts of Colours are produc'd, and we do not find any Figure of Glass, which is capable of exhibiting only one, as Natural Bodies do; from whence we may reasonably conclude, this is nothing more than an Imaginary Solution. But we have consider'd this more fully in another place, and therefore shall omit any farther Prosecution of it.

As to a Reflection of the Globes of Light, causing these Appearances of Colours, by various Incidencies, on the rough Surface of Bodies, it is altogether inconceivable how a Globe, being incident upon a prominent part of a Surface, should receive any other Direction than that with which it fell, that is, it will be reflected with an Angle, equal to that of its Incidence, which is only chang'd by such Asperities, without any new Modification of its Light.

§. 30. In relation to the Examples alledg'd, from what is experienc'd by Dyers, that no Colour is fix'd without the Assistance of Allum, and some not

*The Examples  
alledg'd from  
the Dyers in*

with-



*favour of this without an Addition of Copercas, both which are Hypotheses, dis-*  
*proved.*

Rohault Cap.

27. §. 71. Par. 1.

corroding Bodies, and therefore penetrate into the Substance of the Cloth, and open a passage for the small Particles of Colour to enter; We answer, that this can be no affirmation of the present Doctrine of Colours, because it supposes the colour'd Particles already form'd, and only explains which way it is possible for them to be lodg'd in the Pores or Foramina of the Cloth, which is ting'd by them.

*The Instance of Black consider'd.*

Rohault Cap.

27. §. 72.

§. 31. Lastly, The endeavouring to confirm this, by making Black to depend upon the roughness of the Superficies, on which the Light is incident, is to confirm it, by making Black to consist in what it had made White to consist in before. We shall conclude therefore upon the present Account of Colours, with an Admiration at the Easiness and Credulity of Mankind, and even the most rational part of it, who can persuade themselves to sit down and acquiesce in such Extravagant and Romantick Notions of Nature, and which, as we shall shew, are not condemn'd in the main, but approv'd and vindicated in several Particulars, by those who are thought to propose nothing to the World on this Subject, but strict and invincible Demonstration.

### C H A P. III.

#### *Concerning the New Account of Light and Colours.*

*The New Hypothesis of Light and Colours resolv'd into its chief Doctrine, of which it consists.*

§. 1. **H**AVING consider'd the foregoing Hypothesis of Light and Colours, and shewn the Weakness and Infirmary of it, what can we reasonably inquire into, unless the Validity of a Second, which has been of late propos'd with a more than common Assurance of Demonstration. In

which



which there are 3 Things principally affirm'd; Sir Is. Newt.  
*1<sup>st</sup>*, That Colours, in *Æther*, are the Connate Opticks.  
 Properties of the Rays of Light, namely, that  
 there are different kinds of Rays, which originally  
 and immutably assert a Colour peculiar to them;  
 so some cause the Sensation of Blue in us, others  
 of Green, a third of Red or Orange, or Violet,  
 and so on; and those which have different Co-  
 lours, have likewise different Degrees of Refran-  
 gibility. *2<sup>d</sup>*, That the Colours of transparent co-  
 lour'd Bodies are owing to the particular Com-  
 position and Contexture of their Parts, by which  
 they are made capable of transmitting or reflecting  
 one sort of Rays only. *3<sup>d</sup>*, That the Colours  
 of Opaque Bodies are caus'd by the various Make  
 and Constitution of their Parts, by which they are  
 determin'd to reflect Rays, that are of one certain  
 kind. This is the sum of the Doctrine of Co-  
 lours, and as for Light, that is said to be com-  
 pounded of all the variously colour'd Rays blended  
 and mix'd together.

In relation to the First, namely, that Colours Sir Is. Newt.  
 are the Connate Properties of Light, it depends Opticks, Prop.  
 upon 2 Propositions: *1<sup>st</sup>*, That the Rays of Light, 1, & 2. Par. 1.  
 or Light in general, is differently refrangible: Book 1.  
*2<sup>d</sup>*, That those Rays, which differ in their De-  
 grees of Refrangibility, differ also in Colour; to  
 prove which 2 Propositions 10 Experiments are  
 produc'd, none of which are conclusive of the  
 Assertion.

§. 2. The First and Second Experiments are, *The 1<sup>st</sup> and 2<sup>d</sup>*  
 That if we take Pastboard, and paint it with two *Experiments*  
 different Colours, as Red and Blue, there will be *explain'd, to*  
 a greater Refraction of the Blue than the Red; *evince the Rays*  
 that is, supposing a Square piece of Pastboard, and *of Light, which*  
 one half of it to be laid over with a strong red Paint, *are differently*  
 and the other with a deep or Violet-blue; if this *refrangible,*  
 be look'd upon thro' a Prism, which refracts the *differ also in*  
 Lights of both, the Blue will appear higher or more *Colour.*  
 Sir Is. Newt.  
 Opticks, Book  
 1c-

1. Plate 2. Par. refracted, and the Red lower, if the refracting  
 2. Fig. 11, 12. Angle of the Prism is turn'd upwards. So in the  
 or Fig. §. 7. Second Experiment; if the same Pastboard, which  
 is distinguish'd into Red and Blue, is made use  
 of, and its Rays are collected by a Lens, and the  
 Focus's, after their Transmission thro' it, are ob-  
 serv'd, the Blue will sooner determine its Rays up-  
 on an opposite Wall or Paper, than the Red; that  
 is, the Focus of the Blue will be nearer to the  
 Lens than the Red is, which is suppos'd an Evi-  
 dent Proof, that the one is refracted more than the  
 other; thus, let *MN* be the Lens, the Focus  
 of the Blue will be in *bi*, and of the Red in *HI*,  
 as also *dg* is the Blue  $\frac{1}{2}$  of the Paper, and *fe* the  
 Red.

*The Rays of  
 Light not pro-  
 ved from  
 thence to be dif-  
 ferently refran-  
 gible.*

§. 3. But tho' this were allow'd to be a clear  
 Demonstration, that Red and Blue have different  
 Actions, or different Degrees of Refrangibility,  
 which we can readily acknowledge, since that may  
 be evidenc'd from the different Perceptions we have  
 of them, which various Perceptions must be ow-  
 ing (our Organs of Sensation, and our Minds,  
 which receive the Impressions from those Or-  
 gans continuing the same) to some different Action  
 external to us. Yet we do not so fully conceive  
 how from hence it is prov'd, that the Rays of  
 Light are differently refrangible.

*Arg. 1.*

*Since we may  
 as well assert  
 such a Proper-  
 ty to belong to  
 Light, from our  
 different Per-  
 ceptions of Red  
 and Blue, as  
 from these Ex-  
 periments.*

§. 4. What we mean is, that the Experiments  
 are entirely own'd to be true, notwithstanding  
 which, it no more follows that the Rays of Light  
 are differently refrangible in their own Nature, be-  
 fore their refraction from the different Actions of  
 Red and Blue, observable upon a Wall or Paper,  
 than from their different Actions observable upon  
 our Minds.

So that these Experiments prove nothing farther  
 than our Perceptions do, and we may as justly  
 assert that the Rays of Light are differently re-  
 frangible, because we perceive a Distinction of  
 Red

Red and Blue, as we may, because the Effects of 'em are not every where the same, and alike on the Wall or Paper, or upon our Eye, looking thro' a Prism; that is, both the Cause of our Perceptions of Colours in general, and of the different Appearances upon the Wall, or Paper in particular, cannot be demonstratively prov'd, from the Effects we experience, in the one Case or the other.

The Cause of Perception cannot be immediately evidenc'd from Perception it self; nor the Cause of Heat or Colour from an Impression of those Properties upon us; and for the same Reason, altho' there is a different Action produc'd in our Minds, or on the Paper, it is not from thence certain what the Cause of that Action is, that we should presently pronounce it to be an Innate difference in the refrangibleness of Light, unless there is a necessary and unavoidable Connection betwixt them, which there is not, by what has been said, in the present Section.

For if a different Action upon the Wall; or the Eye looking thro' the Prism, is a reason of the Innate difference in the refrangibility of Light; when we perceive a difference of Action upon our Minds, in our Perceptions of varying Colours, that ought likewise to infer an Innate Difference in the refrangibility of Light, and consequently, where the Rays of Light are uniformly the same, as they may be suppos'd to be, before the contrary is evidenc'd, they are yet, upon this Hypothesis, prov'd to be different, without any Circumstances to cause the Alteration, since the Mind and its Organs of Sense are unvary'd, and the colour'd Body is presum'd to have no Influence in changing the Light, which is reflected from it.

§ 9. What has been alledg'd in the preceding Section, is, that from a bare Contemplation of Effects we cannot always directly and necessarily infer the Cause of 'em; but these Experiments only

*A farther Explication of Argument the first.*



represent the Effects as they lie in Nature, and from thence, without any farther Proof, we are immediately carry'd to the Cause that is suppos'd to produce them, which yet ought never to be done, unless where there is a plain and evident Inference of each other, which by a just Analogy betwixt the Action of Light upon the Mind, and upon a Wall, or on Paper, we have shewn there is not; we shall therefore now prove, from the Experiments themselves, that they do not include the least necessity of the difference of refrangibility in Light.

Arg. 2.

*From a Difference in Distance of Appearance to the Eye, not necessarily proving a different Refraction only.*

§. 6. For, First, tho' the Intervals of Red and Blue are not the same, from the Eye viewing them thro' a Prism, nor meet in the same Focus, when collected by the Lens, it is not certain that these Appearances, differing in their Distances, proceed from a different refraction of Light, unless a difference of the refraction of Light, and a difference in the Distance of any Phænomenons from us are reciprocal Terms, and mutually suppose each other, which it is plain they do not; since albeit, where there is a different refraction, there must be a difference of the Phænomenon in the Distance, yet the contrary do's not always obtain, that where the Distance is different, there must be by consequence a different refraction; and yet these Experiments only assert a difference in the Distance of the Phænomenons, and from thence conclude the other.

If it is said, that a Difference of Distance in the Phænomenon, where Rays are acknowledg'd to be refracted, and a Difference in Refraction are convertible Terms, that is not true neither, for there may be a refraction of Rays, and yet all the Phænomenons, which are consequent upon that refraction, shall not owe their immediate Cause and Existence to such a refraction: Thus, for Instance, the Rays of the *Sun* are refracted and collected by a Lens, and tho' each Ray approaches, and is determin'd

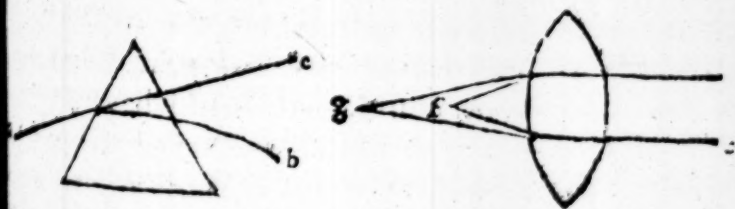


to a Point from its refraction, yet its Heat is not deriv'd from thence, by which, upon an Assemblage of 'em, they become inflammant; and so, tho' Distance or Distinction in the Phænomenon may follow Refraction, yet there may be some other Principle to which it is owing, besides Refraction consider'd by it self. 'Tis by Refraction confess'd, that we see the *Sun* when it sets, and yet the Difference of its apparent Distance, from what it seems to have in its Meridian, is not thought to proceed from the same Cause, but from the Interposition of the Terrestrial Bodies in the one Case, which do not occur in the other.

If therefore a Difference of Refraction in general cannot be inferr'd from a Difference in Distance in any Phænomenons, and where there is Refraction suppos'd, all the Phænomenons that follow are not necessarily deriv'd from it, it will not be certain that a Difference of Distance is deriv'd from a Difference of Refraction only, even where a Difference in Refraction is acknowledg'd.

Lastly, if it is farther argu'd, that a Difference of Distance do's infer a Difference in Refraction, where there is a Different Refraction only consider'd, that is taking for granted, what remains to be prov'd.

§. 7. If nothing of this can be affirm'd absolute- *Not certain*  
ly, it will yet be said in this particular it may, *that the Di-*  
namely, that the Distance of the Phænomenons *stance of the*  
proceeds from a Different Refraction, because it is *Phænomenons,*  
*in this particu-*  
*lar Case, pro-*  
*ceeds from a*  
*Different Re-*  
*fraction only.*



to exactly answerable to the Laws of Refraction thro' a Prism, or a Lens in other Cases; for it is known in a Prism, where its refracting Angle is turn'd

upwards, the Ray that is most refracted is elevated the highest in respect of *a*, which is suppos'd to be the Eye, as *b* is the refracted, and *c* the Elevated Ray, and on the other hand, the Lens collects the Rays which are most refracted to *f*, and which are the least to *g*, so that the Focus of the former should be nearer to the Lens, than that of the latter.

But on the contrary, we say, where a new Property of Light is introduc'd, it is not certain it ought to be explain'd by the Laws of the Old. How is it necessary, that because the Solar Rays admit of such Determinate Refractions in the Prism and Lens, that therefore Colours, whose Nature is suppos'd to be as yet unknown, should be under the same Discipline and Prescription? Besides, this Account, which common Opticks gives us of the Refractions of Light thro' a Prism or Lens, may be justly disputed, as we shall afterwards demonstrate, and that the different Distance, which we perceive in the Phænomenons arising from Refraction, do's not proceed from the different Inflection of the same Rays of Light, but from another Cause.

Arg. 3.

*Since different Refractions do not always cause Colours, there is no Reason why Colours should only proceed from different Refractions.*

§. 8. Hitherto we have consider'd what Arguments can be rationally had, from a Difference of the Distance of the Red and Blue in these Observations, to evince the different refrangibility of the Rays of Light; we shall now inquire, Whether any farther Argument lies against the present Doctrine, from the different refraction of the same Light, falling with various Inclinations on a Lens, since it is certain these Refractions, tho' different, are incapable of exhibiting any colour'd Phænomenons; for if they could, we should have a Sensation of Colours from the refraction of differently figur'd Glasses, and even from those of the same kind, as Convexes, either in different parts of the same Curvity, where the Refractions are different, or in different Curvities where they collect the

Rays

Rays at changing Distances. If therefore, where Rays are differently refracted, there is no Colour consequent from thence; why should we imagine that where there are Colours, they should proceed from a difference in refraction?

§. 9. We would not, however, be thought to deny, that Red and Blue have different Degrees of Action, and consequently of Refrangibility, since in §. 5, we acknowledge it is evident from our very Perceptions; all that we contend for therefore is only this, that these Experiments do not prove, that the Rays of Light, so far as they are colour'd, are differently refracted, or which is the same, that their Colour arises from the Refraction, and consequently that they do not give us a true Explanation of the different Actions of Red and Blue, or of any other Colours.

Arg. 4.

*Supposing a different Refraction, the Rays of Light are not prov'd to be differently refrangible.*

It must be confess'd, that where there is a different Colour, there is a different Refraction; but this no more proves that the Colour of Light consists in a different Refraction, than, because Gold is heavy, and also yellow, it is an Argument that Yellow consists in Gravity; that is, Colour is one Property of Light, as it affects the Eye, and different Refrangibleness when it is transmitted thro' a Prism another; but what the rise and cause of these two different Properties are, is the Question, which cannot be resolv'd by assuming the one to explain the other.

§. 10. This Hypothesis moreover asserts, that the Rays of Light are differently refrangible in their own Nature, and want only refraction to separate them, being mixt and united into one Body of Light. But if the Rays of Light are differently refrangible, yet if they are so from any foreign Cause, extraneous to the Rays of Light themselves, they will not be differently refrangible in their own Nature, and consequently Light may

*Light may be Homogeneous, altho' its Refrangibility thro' a Prism is different.*

be perfectly Homogeneous, albeit this Philosophy affirms the contrary.

Arg. 5.

*The different Refrangibility not prov'd, unless upon the Hypothesis of Homogeneous Matter, the Absurdity of which is shewn in its Application to the present Doctrine.*

§. 11. And yet, in these Experiments, there is nothing more endeavour'd to be prov'd, than that the Rays of Light are in general differently refrangible: For it is taken for granted, that there can be nothing in the colour'd Bodies themselves to produce this Difference of Action in the Rays of Light, because it is presum'd, according to the Hypothesis of Similar Matter, that there is no Distinction betwixt one Body and another, excepting in the Figure and Contexture of the Parts; that Hypothesis therefore ought first to have been evidenc'd, before a second had been introduc'd upon it; since besides the Absurdity of such an Hypothesis it self, there can be nothing more Unreasonable, or Preposterous, than to deduce Heterogeneous Colours, from supposing Matter to be Homogeneous, which, by its different Appearances and Shapes, seems to be Heterogeneous, by the Mediation of Light, which is suppos'd to be Heterogeneous, when in all respects, excepting in this New Representation of it, it seems to be Homogeneous.

Arg. 6.

*That if Refractions only separate the differently colour'd Rays, and do not produce those Colours, all Refractions ought to separate them, which they do not.*

§. 12. And as this Hypothesis depends upon Matter's being Homogeneous, to prove the Rays of Light Heterogeneous, or differently refrangible, so it likewise assumes another Liberty, which cannot be justify'd by these Experiments, namely to infer an Innate Degree of Refrangibility in the Rays of Light, when it is not prov'd, unless by supposing that it may not, some way or other, be accidental to it; for if every Ray of Light has its particular Degree of Refrangibility, it will be necessary, either that every Refraction will separate them, or that there is something peculiar in those Refractions that do; which, if allow'd, the different refrangibility of the Rays of Light is not a necessary and essential Property of Light.



Light, but only accidental upon certain particular Refractions: for whatever may be said to elude this Objection, by shewing the Colours will not be produc'd from plain Glasses, or from the Lens, &c. according to the Manuscript we have seen, they are only Artificial Evasions, to get quit of the present Difficulty.

Sir Is. Newt.  
Opticks Ma-  
nuscript.

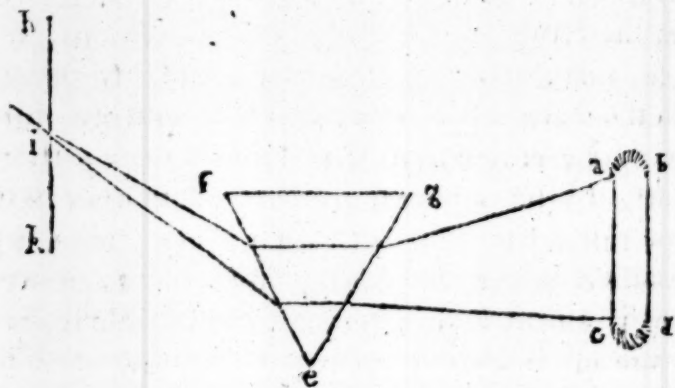
§. 13. Lastly, If there is a Difference of Re-Arg. 7.  
frangibility observable in the Effect, after the Transmission of the Rays thro' a Prism, it is not necessary the same should be permanent and constant in the Cause, as the Rays of Light, before that Effect was produc'd, and before their Trans-  
*A Capacity of being differently refracted, no proof of the Rays of Light being originally different in their Refrangibility.*  
mission. Thus, for Instance, that Brightness which we perceive upon the Refraction of the Rays thro' a Sphærical Glass to a Focus, no one will say existed in Light, when it was diffus'd, and before its Collection: 'Tis true, there was a Capacity in the Rays of Light to be collected to a Focus, and so there is of diverging from one by the Intervention of a Concave; But it cannot be therefore affirm'd, that Light is differently refrangible upon that Account: Light is Homogeneous in its own Nature, notwithstanding these different Refractions, which are solv'd upon the Supposition of its being so; since, if Light was differently refrangible in its own Nature and Heterogeneous, a Concave and Convex might equally determine it to one Focus; For if those Rays, which are more languidly refracted, are collected to a Focus by a Lens, others, which are more strongly refracted, might meet in a Focus from a Concave, or at least they would not preserve those distinct Properties of Collecting and Dispersing the Rays of Light, excepting upon the Supposition of Light's being Homogeneous. And the same Reasoning, as we shall afterwards shew, will hold in the different Refractions of Colours, which must necessarily be accounted for upon this very Hypothesis of Homogeneous Light; but this

will more Naturally fall under the Third Experiment, which we shall now explain.

*The Third Experiment explain'd.*

Sir Is. Newt.  
Opticks, Prop.  
2. Par. 1. Book  
1. Exp. 3.

§. 14. In this Experiment the Room is made perfectly dark, and there is only one Ingress permitted to the Light, thro' a small Perforation *i* in the Shut of the Window *hk*, to which a Glass Prism *feg* is oppos'd, perpendicular in its Axis to the incident Rays; at the Distance of 18 Feet and a half an Image is cast upon the opposite Wall, which upon the turning of the Prism round upon its Axis, ascends and descends, and is then stationary, when the Rays that are incident are refracted with the same Angle, with which they fell: This Spectrum, as it is call'd, was of an oblong Form, having two parallel Sides, and two Semicircular ends express'd by the Figure *abcd*, as the Triangular Section of the Prism is by *feg*; the Breadth



of the Image *ab* was two Inches  $\frac{1}{8}$ , and answer'd to the *Sun's* apparent Diameter, including the Penumbra, which was one part of this Appearance; the Length of the Image was about 10 Inches and a Quarter, and the Length of the Rectilineal sides about 8 Inches. The refracting Angle *feg* of the Prism was 64 Degrees, and with a less Angle the Length of the Image was less, the Breadth remaining the same; If the Prism was turn'd about its Axis that way, which made the Rays emerge more obliquely out of the 2<sup>d</sup> refracting Surface of the Prism

Prism *ge*, the Image increas'd in Length an Inch or two, or more; if the contrary way, so as to make the Rays fall more obliquely on the first refracting Surface *fe*, the Image became an Inch or two shorter; but the Prism being plac'd in the stationary posture, as before describ'd, the Rays fell perpendicular upon the opposite Wall. It was farther observable, that different Angles of Refraction in the Prism, as *fe g*, caus'd the same Length of the Image nearly, and that the different Magnitude in the Perforation of the Window-shut, and the different Thickness of the Prism where the Rays pass'd thro', and the different Inclinations of the Prism to the Horizon, made no sensible changes in the Length of the Image neither, nor yet the different Matter of the Prisms, since a hollow Glass Prism, fill'd with Water, would produce the same Effects. This notwithstanding, it is evident from the Laws of Opticks, that Rays which fall upon a Glass in a certain Angle, and are refracted with the same, upon their egress cannot describe an Oblong Figure, where they enter with a Circular; farther, it is likewise experimented, that at *cd*, which is said to be the least refracted End of the Image, a Red Colour is observ'd, and at *ba*, where is likewise affirm'd to be the greatest Refraction, the Colour is Violet, or a deep Blue, and the Intermediate Spaces exhibit from Red, in order, Orange, Yellow, Green, Blue, Indigo, to the Violet.

§. 15. We have endeavour'd to give a full and perfect Description of this Third Experiment, since the whole of the present Doctrine was form'd and contriv'd upon it, all the other Experiments, which follow, stand or fall upon this Foundation, and are only several Variations of it. In the resuming of which, whatever has been argu'd from §. 6<sup>th</sup>, 8<sup>th</sup>, 10<sup>th</sup>, 13<sup>th</sup>, might be here repeated; but we shall here principally pursue, what is more

*The foregoing Experiment the Foundation of the present Doctrine of Light and Colours.*

pecu-

peculiar to the Phænomenon we are now to examine.

*The present  
Doctrine of  
Light and Co-  
lours not prov'd  
from thence.*

Arg. 1.

*From a Dar-  
kened Medium,  
being requisite  
to form the ex-  
act Image be-  
fore describ'd.*

§. 16. In Confutation of what is concluded from this Experiment, namely, that Light is Heterogeneous in it self, we cannot but in the first place observe, that it is necessary the Room should be dark, and Light prohibited from passing any where, excepting thro' the Foramen in the Shut of the Window, to which the Prism is oppos'd: But if Darkness is requisite to this certain Appearance of Colours, and to the perfect Shape and Dimensions of the Image, which is projected upon the Wall, it will follow that these Colours, and that Image, in some measure, proceed from a certain, and we will suppose at present, an unknown Action betwixt Light and Darkness, after the Transmission of the Rays thro' the Prism, which Quality Light had not before its passing into a different Medium, as that of the darken'd Æther, and therefore cannot, from such an Effect, be deem'd, or imagin'd, to consist of an Heterogeneous Nature, unless Light is presum'd to be the same as Darkness.

If the Medium of Light and Darkness are the same, there ought to be the same Colours in the Vivacity of 'em, and the same Image in its Clearness and Distinction produc'd, without any such Preparations as this Experiment supposes; and consequently a Prism, oppos'd to the Rays of the Sun, shall produce the same Phænomenons upon a Wall that is illuminated, and set in the broad Light of Day, as well as upon one that is obscur'd, and forbid any other approaching it, excepting what makes its passage thro' the above-mention'd Foramen; which if it can, all this Preparation is of no Significancy or Importance.

Arg. 2.

*From the Pen-  
umbra that  
lines the sides of*

§. 17. Moreover, what gives an additional Force to this Reasoning, that Light assumes these Properties and Conditions, after its Refraction and Trans-



Transmission thro' the Prism, and unenlightn'd *the Image,*  
 Æther, which it had not before, is, that a Penumbra *which no one*  
 is observ'd to line and edge, as it were, the Sides *will affirm to*  
 of the Spectrum; but no one will affirm therefore *have existed*  
 that Shadow existed originally in Light, and was *originally in*  
 not superinduc'd upon it, by the Intervention of *Light.*  
 some Cause or other external to it; and there is  
 the same Reason to think, that the Colours exhi-  
 bited on the Wall, are only different sorts of Shades  
 produc'd from some hitherto unknown Affections  
 in the Prism, and the Darken'd Medium, which  
 we shall afterwards explain; and that they had no  
 Being in Light before their Refraction, excepting in  
 a Capacity of changing into these several Forms, upon  
 their being diffus'd and shatter'd by the Prism, into a  
 different Æther, and from their various Refractions.

§. 18. That Colours are different Shades of Light Arg. 3.  
 seems to be farther evinc'd, from their fading like *From the Ana-*  
 common Shadows upon the Ingress of the *Sun's* *logy of the Co-*  
 Rays, and submitting their weaker Action, more *lours of the*  
 or less, to the stronger and more forcible it im- *Image with*  
 ports. Whereas were they produc'd from Lights, *common Sha-*  
 which were variously refrangible in their own Na-  
 ture, and which mix'd and united together made  
 by its Complexion that Light we behold, since  
 some Rays are acknowledg'd, upon this Hypothesis,  
 to have a less degree of Refrangibility, and others  
 a greater, than that, which is a middle Composi-  
 tion of all, and since likewise those Rays, which are  
 more refracted, have a less Action, and those which  
 are less, a greater, it would necessarily ensue, that,  
 since some parts of this Image or Spectrum would  
 more powerfully affect our Organs of Seeing than  
 the Rays of the *Sun* themselves, tho' they were  
 permitted to enter, the Light, upon its Admission,  
 would only obscure the more refrangible part of  
 the Image, and leave the other entire: On the  
 other hand, seeing that part of the Spectrum is also  
 found to appear, and both parts are diminish'd in  
 pro-

proportion to the Light that flows in upon them, it seems to be a Demonstration that all the refracted Lights are weaker than the *Sun's*, as Shadows are, whose Nature they seem to imitate, (for shadows cast or reflected by a Prism are likewise visible in a full Light of the *Sun*) and are therefore not separate and divided forces of it, shatter'd and dispers'd, according to the Doctrine before expounded, to several sides, but various Enervations or Defects of the same Individual Homogeneous Light, according to its different Influxes into an enlightned or darken'd Medium, and according to the different Angle and Thickness of the Prism and the Parts of it, thro' which it is transmitted.

Arg. 4.

*That Colours, from the Refraction, are Modifications of Light, and not originally in it, prov'd from the Experiment of a Lens.*

§. 19. This still will be more obvious, if we consider what may be easily experimented, namely, that if we take a Lens, and, having oppos'd it to the Foramen in the Window-shut, suffer the Light to be trajected thro' it, the Rays thus refracted, and receiv'd upon a Paper, will be so far from exhibiting any Colours, that they will represent the Clouds, which pass, in their Natural Brightness and Clearness; on the contrary, if the Lens is carry'd deeper into the room, and, by removing the Paper farther from it, is made to collect the Rays to a Focus, there are Colours apparently produc'd, but with little or no Order or Distinction.

Which seems to be a Proof, that, where the Rays fall on the thinner parts of the Lens, and are carry'd farther into the darken'd Medium, which is the present Case, those Affections of Colour are produc'd in Light, which before did not belong to it: What the Reason of this is, we are not yet oblig'd to explain, 'till we come to establish the Principles of that Philosophy which we are desirous to advance.

It is sufficient, that Colour, in *Æther*, is only a certain kind of Shadow, when refracted thro' a Prism, since

since in different Places of the same darken'd Medium, and by a different Thickness of the parts of the same Lens, it is evidently caus'd, whereas in other Circumstances it is not.

§. 20. Besides, what Account can be given why a hundred Refractions of Light are perform'd, from which no Colours ensue? which seems to be impossible, if Light was in its own Nature Heterogeneous, and it was its property to divide upon its being refracted, as has been before observ'd. *That there are several Refractions from which no Colours ensue.*

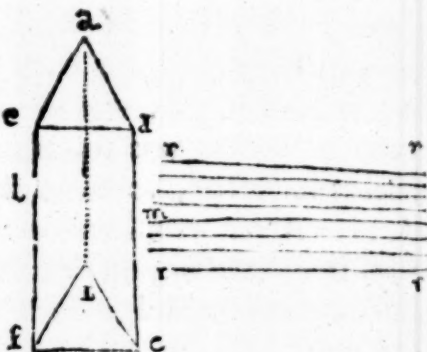
§. 21. After considering the Colours of this Image, it will be necessary to examine into the Dimensions of it, which it is said could not any ways be accounted for, unless by supposing that the Rays of Light were dispers'd, and differently refracted in their being transmitted thro' the Prism; for it is thought to be impossible, by the Laws of Refraction, that any Rays, which fall upon a Prism in a Circular Figure, should not come out with the same, where the Angle of Incidence and of the second Refraction is equal. *After its Colours, the Dimensions of the Image are to be consider'd.*

§. 22. In answer to which, we shall, without any Foramen in a Window-shut, or a dark room, describe what may be experienc'd at any time in open Light, and if the Supposition of a darken'd Medium is capable of solving what we experience in an enlightn'd one, we may as well take the one as the other; If it is not, there is no reason can be alledg'd, why we should rather explain the Phenomenons of an illuminated Medium by a dark, than a dark by an illuminated. *No Reason why we should explain the Phenomenons of a Prism by a darken'd Medium, rather than an enlightn'd.*

§. 23. In an illuminated one the Experiment is this, That if a Prism is held against the Rays of the Sun, so as they should fall directly upon its Axis, which is plac'd in a parallel Situation to the Horizon, with the refracting Angle, or the edge of the Prism downward, and the opposite side exactly corresponding to the roof of the Chamber, Thus let *edcf* represent the uppermost Surface of the *The Experiments made upon a Prism in an enlightn'd Medium.*



the Prism,  $ab$  the edge,  $rr$  the Rays, which in respect of  $dc$  or  $ab$ , or the Axis parallel to them, are in a perpendicular Direction, there will 5 several Images result from this Position of the Prism, 3 of Light, and 2 distinguish'd into various Colours; the first of which are evidently  $e$  produc'd by the reflection of the 2 sides of the Prism, which are oppos'd to the Sun's Rays  $edfc$ , and  $adcb$ , since either



of 'em vanish, if  $edfc$  is obscur'd, and the 3<sup>d</sup> if  $adcb$  is, and not else. It is likewise observable, that the 2 Images reflected from  $edfc$  are projected to different parts, the one towards  $l$ , which is the Brightest, and the other towards  $m$ , which is more faint and languid, and therefore seems to be a Re-action of the Image at  $l$ , upon the Surface  $edfc$ , from whence it is reflected to  $m$ ; and it is not improbable but the same would happen in respect of the Surface  $adbc$ , if there was a due Position to receive the Impress, or if the Reflecting Body was hard and consistent, instead of the Hanging of the Room, upon which this Image was projected; that these Images are reflected is farther evident, from the Circuit they describe, by turning the Prism round upon its Axis, suitable to what is experienc'd in polish'd Steel, which are alike revolv'd, and from the Incidence of the Rays, which slide off much in the same manner, and with the same Law that they fall, so as one Surface of the Prism soon loses its Image in revolution, which is taken up and supply'd by another, as the sides retire and are averse from the Sun, and others advance towards it. There are two things more to be taken notice of, in relation to these reflected Images: First, the Rays which



which are reflected from  $edcf$  produce a broader Image than that which is reflected from  $adcb$ : The Second is, that a Stream of dusky Light is sometimes observ'd to issue forth from both ends of the reflected Images, and upon the decay of the *Sun's* Force the whole Image seems to spread and diffuse it self into a large Ambitus, which is proportionably impair'd in its Brightness, 'as the incident Rays in their Strength. To which we may add, That if these reflected Images are projected in the full Light of the *Sun*, they lose of their Brightness, yet preserve their Distinction, and are not wholly obscur'd by the stronger Action of the descending Rays. The other sort of Images are colour'd, and are two also in number; tho' sometimes I have observ'd 2 likewise, besides the first, of a weaker Impression, namely, when the *Sun* has obtain'd its utmost Force of Action, which seem to be made from the Re-action of the *Sun's* Beams, or of the Primary and Brighter Images, upon the sides of the Prism: As for the two Vivid and Lively Images painted, the one on the Roof, and the other on the Floor, upon opposing the Prism to the *Sun*, as the former were from reflection, these, on the contrary, are evidently from refraction, since the Rays which fall on  $adbc$ , passing also thro'  $abfe$ , are turn'd upwards from  $l$  to the roof of the Chamber, at some Distance from the Prism; this Spectrum is always much longer than the other, which we shall afterwards describe, and if either of the sides we have mention'd are obscur'd, vanishes, but do's not, if  $edfc$  is; on the other hand, the Rays which fall on  $edfc$  pass thro'  $eabf$ , and are refracted downwards to the Floor of the Chamber, at a short distance from the Prism, it is of a less Length than the former, and scarcely exceeds the Breadth of one of the sides of the Prism, and also vanishes, if either of the last mention'd Surfaces are obscur'd, but do's not if  $adbc$  is;

is; it is farther experienc'd, that if  $edcf$ , by a gradual Revolution of the Prism upon its Axis, is made to move from  $l$ , so as the edge  $ef$  should approach to  $m$ , the Image on the Floor is lengthen'd, and draws nearer to  $ab$ , and the several Orders of Colours tremble and move like so many languid Flames, grow scatter'd and diffus'd, and at length wholly disappear. But if  $edcf$  is revolv'd the contrary way towards  $l$ , the Image shortens, and the Colours vanish by degrees; without any such Trembling Motion; on the other side, if  $edfc$  is revolv'd from  $m$  towards  $l$ , the same will happen to the longer Image projected on the roof of the Chamber, that it will lengthen, grow bright and tremulous, and at last vanish, as before was said to arrive to the other upon a contrary Motion; and if it is mov'd from  $l$  to  $m$ , the Image will gradually disappear without any alteration, unless by contracting the several Orders of Colours; and this is common to both of them (even with the reflected Images) in their Stationary Posture, to emit long Trains of Light, which lie in small and slender Beams, representing a Penumbra, and which follow the Motion of the refracted Images.

Farther, both these Images very nearly appear and vanish at the same time, and would probably exactly do it, if all the Angles of the same Prism were equal, which they were not in that which we made use of; they also describe, upon the Revolution of the Prism, a very small Circuit in their Appearance, as it is necessary they should, if they proceed from Refraction. Again, If the Rays of Light, which are incident on the Prism, grow faint and languish from the Interposition of Clouds, sometimes each of the Images are divided into two less vivid, and at other times are confus'd into an undistinguish'd, and a large Colour'd Spectrum. Lastly, If they are projected on the Rays of the Sun, acting with their full Force, they lose (as the

reflected Images before) their Clearness, they become only just discernible from the Light, which obscures them, and seem like Colours that are upon the point of vanishing.

§. 24. From this short History of the Affections of Light and the Prism, compar'd with what has been recounted of 'em, where the Medium is darken'd, may be plainly collected, that all these Phenomenons are produc'd from a different Weakness of the Rays of Light, which Weakness, or Impairment of their Force, could not be originally in the Rays of Light themselves, and therefore Light is not from hence, nor cannot be prov'd, from any of these Experiments, to be Heterogeneous in its own Nature, previous to its Refractions; we shall therefore go thro' these several Observations, and evidence that nothing of that which this Doctrine advances can be concluded from them.

*From a general survey of the preceding Experiments it is evident, that the colour'd Phenomenons of a Prism, are produc'd from the Refraction of the Light incident upon it, and therefore not originally in Light it self.*

§. 25. We may therefore, in the first place, easily allow, that the reflected Images consist of a Light, which is less Forcible than the Incident Rays: This is manifest to our Sight, since they are not endu'd with that Vivacity and Brightness, which we perceive in the Rays themselves; besides which, when the Incident Rays are diminish'd in their Lustre, a perfect Shadow results from the Reflection of the Prism, and becomes large and diffus'd, suitable to what always follows from a Weakness of Action; but this, I am apt to think, will scarcely be affirm'd, that Rays, which are reflected, have a Force equal to the Incident, and therefore it may seem superfluous to endeavour at a Proof to the contrary.

*Arg. 1. The reflected Images weaker in their Light, than that which is observable in the Incident Rays.*

§. 26. If this is granted, it is likewise as certain and infallible, that this diminish'd Light from Reflection, was not in the Rays of Light before Reflection, as that the Incident Rays are not the reflected, or that Light is not Darkness; since therefore the Incident Rays of Light are apparent-

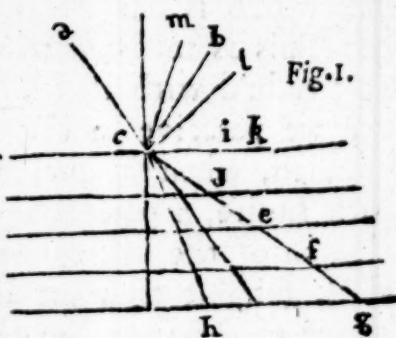
*Arg. 1. If the Light of the reflected Images is alter'd, it is still more reasonable to affirm,*



that the Light  
of the refracted  
Image is.

ly chang'd, from what they were before, by a Reflection from the Prism, it is not possible for any one to conceive, that the Refraction of 'em thro' a Prism, should better preserve their Nature; if it do's not, Light is different after its Refraction, from what it was before its Incidence, and consequently it cannot be inferr'd that Light was Heterogeneous before such Refraction, because it is so after it; if Refraction do's better preserve their Nature, that is, if Refraction makes a less Alteration in the Nature of Light than Reflection do's, in the first place, we must affirm, that the colour'd Spectrum comes nearer to Light than the reflected Image, which is contrary to our Senses; and 2d, that refracting Telescopes are preferable to the reflecting polish'd ones, which is disavow'd by this Doctrine.

§. 27. Let us farther examine into the Analogy there is betwixt Reflection and Refraction, and the Images produc'd by them; and first, as to the Nature of these two Actions, it is very evident that they do not differ, since Refraction is only a continu'd Reflection thro' the Fluid, at a different Angle from that of Incidence, whereas Reflection is perform'd in the same Fluid, and in the same Angle. Thus let *ac* represent a Force descending from *a* to the Point *c*, that which falls on the side of it, is reflected to *d*, thro' the Points *e*, *f* and *g*, from the Perpendicular, or else the contrary way to *b*; if therefore the Rays are separated from each other by their lateral Reflection, *i. e.* from the side of the Point *c*, there will be the same Reason they should be likewise separated by their Vertical Reflection, *i. e.* from the top of it, since the Nature of the Fluid is the same which reflects, and only differs in this, that



the



the Parts of it towards *i k* rather suppress and hinder the Separation in Refraction, than assist it, and consequently the reflected Image would be colour'd, contrary to Experience; if the Rays are not separated in their lateral Reflection from *c* to *d*, it would follow that the refracted Image, according to this Philosophy, would not be colour'd, which on the other hand is contrary to Experience.

§. 28. It is also to be observ'd, that the Angles Arg. 3. of Reflection being equal to those of Incidence, is *if there was originally a different Refrangibility in the Rays of Light, precedents to their Actual Refraction, it ought to appear as well by Reflection as Refraction.* prov'd from a Supposition, that *cb* is describ'd in the same Time and with the same Force with *ac*; therefore let a Beam of Light *ac* descend at once to *c*, which it is as certain it do's, as that any other Experiment concerning it is true, and is confess'd by this Philosophy; If now there was any Distinction in the Force of the Rays, at the Point *c*, antecedent to their Refraction, we say, it ought to be alike discover'd by Reflection, since the Dissimilar Rays

Fig. 1. would be unequally reflected to *m* and *l*;

for Fig. 2. *ac* is = to *cb*, because the Forces of which they are compounded are equal, namely,  $af + ac = fb + bd$ ; but  $ac = bd$ , or

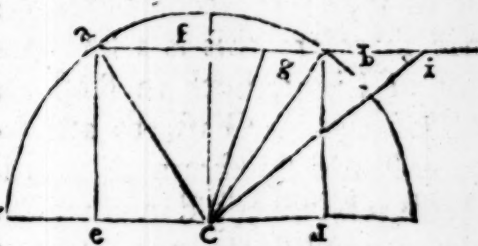


Fig. 2.

the Force of Descent remaining still the same, if *fi* is greater than *fb*, or *fg* less, it is evident the Reflection will be in the first Case to *i*, and in the last to *g*, which is the case of Heterogeneous Rays descending at once from *a* to *c*, and reflected from thence.

§. 29. Having consider'd the Nature of these Arg. 4. two Actions, in their Comparison with one another, let us now inquire into that of the Images produc'd from them. They have both of them Streams of a dusky Light, flowing from their extremities, and the colour'd Image is enlarg'd and contracted, according to the different Incidences of the *A Dusky Light flows both from the reflected and refracted Images, and there is a variable the Contraction*

and Dilatation  
in both.

the Rays, as the reflected ones are; if therefore the Properties of the last were never imagin'd or conceiv'd to exist in Light before Reflection, there cannot be any just Reason assign'd, why, before Refraction, the Properties of the first should, and if not these, why any others, which are the Consequences of it.

Arg. 5.

*The Dissipation  
of the Rays of  
Light, both in  
Reflection and  
Refraction, a  
Proof of their  
being weaken'd.*

§. 30. Besides which, in the reflected Images, they are manifestly dissipated and dispers'd, to a wide Ambitus, upon the Decay of Light, which is also consequent in its Refraction thro' a Lens: For, tho' Rays, when strong and active, are collected to a Focus, so as to put into a Flame certain Objects, which are plac'd in it; yet as the Force of those Rays declines, the Focus is by degrees spread and diffus'd, and casts it self into a thin and diluted Spectrum: From whence it is plain, that it is an undoubted Property of Light, to overcome the Opposition made by the Glass to its Action, when it obtains its entire Force and Energy, and to yield and in some Measure submit to it, as it becomes more weak and languid; since therefore this is a known and evident Affection of Light, both in Reflection from, and Refraction thro' a Glass, to attribute the Length of the colour'd Spectrum to a different Cause, than what is acknowledg'd in other Cases, is neither agreeable to good Sense, nor a true Philosophy.

Arg. 6.

*From the colour'd Spectrum  
being no longer  
in some Inci-  
dences of the  
Sun's Rays,  
than the side of  
the Refracting  
Prism.*

§. 31. But to set this Matter beyond Dispute, it is observ'd in the Fig. §. 23, that the reflected Image from *edfc* is larger than that from *adcb*, on the contrary, the refracted Image, which is made by the Light incident on *edfc* is much shorter, and more contracted, than that which is form'd by the Light, which is incident on *adcb*; which is a Demonstration, that as there is a stronger or more direct, or a fuller Action of Light requir'd to produce a larger reflected Image, and a weaker or more oblique to produce a lesser, so on the other hand, that a stronger or more direct, or a fuller action of Light is requir'd to produce a lesser

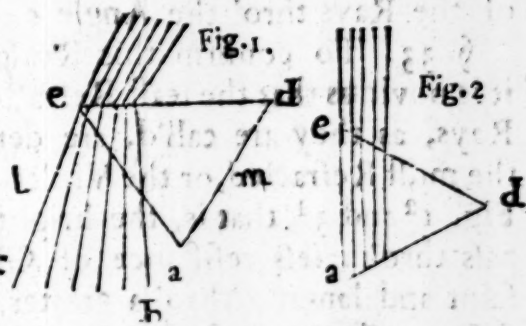
lesser refracted Image, and a weaker or more oblique a larger, suitable still to the Nature of common shadows; and if it is acknowledg'd, that the Rays, when suppos'd Similar or the same, acting differently, or under different Circumstances, may produce this Length, in respect of the whole Image, it will equally hold in the several parts of it, namely, that every particular Length, in the several Orders of Colours, is to be deduc'd from the different Action or Circumstance of the same Rays; but that which would be a sufficient Confutation of this kind of Arguing from the Length of the Image, is, that the Spectrum, with all its Distinctions of Colour, is, in some Incidences of the Rays, no longer than the Breadth of the Prism which refracts them.

Arg. 7.

*From the several distinct Orders of Colours in the refracted Images, being more or less enlarg'd, as the Incidencies of the Rays, or the Opposition of the Prism is various.*

§. 32. That the several Parts of the colour'd Image follow the same Laws with the whole, is also manifest, from turning the Prism round upon its Axis, from *l* towards *m*; for by that Means all the Orders of the Colours will be lengthen'd in the Image, which is projected upon the Floor, thro' the Sides of the Prism *edfc* and *eabf*, that is, by making the Rays *rrrr* to fall more obliquely upon *edfc*, or pass thro' a thicker portion of the Glass, either of which must necessarily diminish the Action of the same Rays, insomuch that when the Rays are to pass thro' the whole Body of the Prism, from the Surface *edfc*, to the edge *ab*, the whole Image presently disappears.

Thus, suppose *eda* to be a Plane in the Prism, parallel to its Extremities; in the first Figure, the Rays, falling with a certain Incidence near the

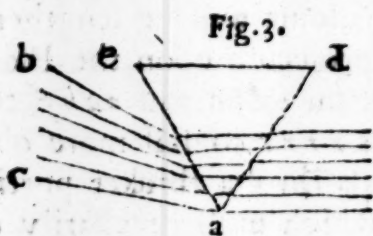


Angle *e*, have different thicknesses of the Glass, to



be refracted thro', from whence they come to be differently weaken'd, and consequently to appear colour'd, as well as diffus'd; but upon the revolving of  $e$  towards  $d$ , the same Rays fall, as in Fig. 2<sup>d</sup>, so as to meet with the resistance of the whole Line  $ea$ , from whence the Colours immediately vanish, as not being able to transmit themselves thro' so large a Space of Glass, and a Shadow or Interception of the whole Rays succeeds.

As this happens in the Image  $cb$ , which is cast upon the Floor, as before describ'd §. 23, so the same arrives to the colour'd Image, projected upon the Roof of the Chamber, by a contrary Motion of the Prism from  $d$  towards  $e$ . Thus Figure 3<sup>d</sup>  $cb$  represents the Image refracted to the Roof, as it did before the Image on the Floor, if the Prism is revolv'd from  $d$  towards  $e$ , as in Fig. 4<sup>th</sup>, the Rays will fall upon the side of the Triangle  $ae$ ,



as before, and for the same Reason the colour'd Image vanishes, and introduces a perfect Shadow in its place, whilst in Fig. 3<sup>d</sup>,  $cb$  appears in all its Distinctions of Colours, by a various Refraction of the Rays thro' the Angle  $ead$ .

Arg. 8.

From the Brightness and most Vivid colour'd Rays, passing thro' a less thickness of Glass, and of the faintest and most languid thro' a greater.

§. 33. To confirm this Reasoning still farther, it is obvious that the least Refracted or Red-making Rays, as they are call'd, are determin'd to  $c$ , and the most Refracted, or the Violet-making towards  $b$ , Fig. 1<sup>st</sup> and 3<sup>d</sup>, that is, the brightest and most vivid pass thro' a less resistance of Glass, and the most faint and languid thro' a greater, which therefore seems to be a Proof, that betwixt the Point  $e$ , Fig.

1, or



1, or *a* Fig. 3, where Light proceeds without Interruption, and the Line *da*, Fig. 1, or *de* Fig. 3, where none is transmitted, all the intermediate Colours from Red to Violet, are only various Shades of Light, according as it is more or less resisted in its Refraction; since especially as Red approaches the nearest to the Colour of the *Sun*, so Purple has the next resemblance to a Shadow, or an absolute Privation of the Solar Rays; and this is still more evident from the Experiments made upon the thin Plates of Water or Air in this Philosophy, and those on *Muscovy* Glass by Dr. Hook, in his *Micrographia*. Sir Is. Newt. Opticks Par. 1. 2. Book 2. Dr. Hook's Micrograph. Observ. 9. P. 47.

§. 34. If we also add, that the weaker the Light is, the larger is the Image projected by Refraction, as is evident from §. 30, seeing the Length of the Blue Image is much greater than that of the Red, and the Red much greater, when it meets with a greater Opposition, than when it do's with a less, from the Inclination of the Prism, or is impress'd with a less Force from the languishing of the *Sun's* Rays by a Cloud, what can we reasonably conclude, unless that the colour'd Rays are, upon this Account likewise, answerable in their Properties to those of a shaded or alter'd Light express'd in §. 30<sup>th</sup>? Arg. 9. From the Blue Image being greater than the Red, and one Red Image greater than another, where the Opposition to the Incident Rays is greater, or the Force of the Rays less.

§. 35. By §. 14, it was experimented, that, the refracting Angle being 64 Degrees, with a less Angle the Length of the colour'd Image was less, the Breadth remaining the same, and consequently with a greater Angle, the Image must be proportionably increas'd; which is suitable to what we have asserted, since in the first Case, the resistance is less, and in the last greater; that is, the Light will be stronger in the former Instance, and therefore less diffus'd, and in the latter, as the Force of it is impair'd, it must of necessity be more scatter'd and diluted, which is exactly correspondent to all other Shadows, and is an Argument for us to Arg. 10. From the Image being increas'd, or diminish'd, as the Angle is greater or less than 64 Degrees.

think, that the Colours of a Prism are not any thing different from them.

Arg. 11.

*From an Agreement between the reflected and Refracted Images, when projected in the Rays of the Sun.*

§. 36. Lastly, the colour'd Images, as other Shadows, do not only owe their Distinctions of Colour to the Interposition of some Body, but to the Quality of the Medium also, into which they are refracted. Thus in the full and direct Rays of the *Sun*, as the reflected Image, cast upon them, loses of its Brightness, and in Darkness acquires one, so do's the refracted likewise; from whence it is evident, that as on the one hand the Distinction of the reflected Image is less, or greater, as the Action of the *Sun*, on the contrary, is greater or less; so on the other, the refracted is subject to the same Laws.

*If the Affections or Properties of the reflected Images are not originally in Light, those of the refracted are not.*

§. 37. If therefore Shadow is own'd not to be in Light Pre-existent to its Reflection, and those Images, which arise from Refraction, are nothing else but different Shadows; it is very Demonstrable, that Colours, or the foregoing refracted Images, are not originally in Light, but are various Modifications of the same Homogeneous Light, according as it is subjected to various Circumstances and Conditions of the Medium of Glass, or *Æther*, thro' which it passes; for if it is objected, that a Prism, fill'd with Water, produces the same Effects, as a solid Prism do's, we in the first place answer, That we own it produces the same kind of Colours, but not the same distinct and individual ones, supposing their Transmission thro' Water; as if the Images are cast upon the Rays of the *Sun*, there is a Distinction of Red and Blue, taking those Terms in a general Sense; but the Red and Blue in one Case, is as different from the Red and Blue in the other, as the Green of a Laurel is from that of a Willow. 2d, We reply, that since these colour'd Images are produc'd, by what foregoes, from the Edges of the Prism chiefly, and not from the Body of it, it matters not whether the Substance of the Prism consists of Glass or Water.

*The Objection of the Prism, being fill'd with Water, answer'd.*

For,

For, besides what has been already advanc'd, it is evident, that if we look thro' the thicker parts of a Prism, no Colours at all appear, and do not rise in the Revolution of it, till one of the Edges comes towards the Eye; on the other hand, if the Edges of the Prism are taken off, one of which I have at present by me, the Colours are more difficultly seen, and those, which present themselves to us, are less strong and vivid, and of a narrower Compass: So that if the Edges were still made more blunt and obtuse, it is probable they would wholly vanish; and for the same Reason it is, that in a Globe of Glass no Colours are apparent, excepting at a small Point or Arch of its Circumference, thro' which the Light is trajected, which alone would be a sufficient Confutation of the Doctrine of the Rainbow, as it is here of that of the Prism, both which make Light to be refracted thro' the Body of the Glass Substance, in order to produce Colours, whereas no such thing is done, and which we shall shew in our Principles to be impossible.

§. 38. When we speak of Shadows of Light, Arg. 12. and when we say Colours, as they are refracted thro' a Prism, are no other, it is certain that we make all Colours of a weaker Nature, than that of Light, and consequently, one would think, the Weaker Rays ought to submit to the Stronger, which it is evident they must, if we consider the Rays of Light themselves, without any Action in the Body, from which they are reflected, or thro' which they are refracted, which this Philosophy only do's; how therefore the Shadow of a Prism, projected by Reflection, or the colour'd Image by Refraction, should preserve their Distinction in the Rays of the Sun, when the first is acknowledg'd, and the last prov'd to be weaker, cannot be shewn from this Philosophy; what we are now to know, is, Whether the Rays of the Sun are diminish'd in

*The Reflected and Refracted Images not disappearing in the Rays of the Sun, nor yet preserving their full Force and Vivacity, a Proof that there is nothing Innate in the Colours of Light.*



in their Action, in different Circumstances of Opposition from the Prism or *Æther*; and if they are, Whether, in the 1<sup>st</sup> place, Colour as well as Shadow, as they are produc'd from the Prism, may not be accounted for, from such a Diminution; and in the 2<sup>d</sup>, Whether we might not argue, that Abstracting from every thing else, but the Force of the Light, and the bare resistance of the Glass, both Shadow and Colour ought wholly to disappear in the Rays of the *Sun*, as they are more languid in their Action, or else affirm their own Natural Vivacity, and the Force peculiar to them, neither of which we experience; which is therefore a manifest Sign, that the reflected or refracted Images have not any thing Innate, and owe their Existence, not to the Original Properties of the Rays, but to the various Conditions under which they lie, and the different Relations of Action they have and obtain, in respect of their own Force, and of that of the Bodies, upon which they act.

Arg. 13.

*From the several Phenomenons of Light in different Circumstances, compar'd with the Phenomenons of other Bodies in different Circumstances.*

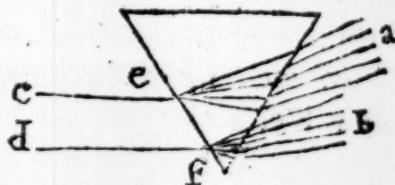
§. 39. For let us imagine any other Case than that of Light, suppose it Water; because it dissolves Salt, quenches Fire, and in other Applications has still different Effects; is it reasonable for us from hence to conclude, that Water has these Effects originally, before such Applications? Light, when it is reflected from a Prism, causes a bright Shadow, when refracted thro' it, colours, when transmitted thro' a Lens, it gathers to a Focus, thro' a Concave diverges from one; will any one upon that Account, and for that Reason affirm, that therefore these Effects exist previously in Light to its Refraction? If not, there cannot be any just Argument alledg'd, why Colours, in particular, should be excepted; and whilst, in all other Instances, Light changes its Nature and Complexion, according to its different Interferings with other Bodies, why in its Transmission thro' a Prism, it should



should not, but on the contrary, should display those obstinate and invincible Properties, which remain unalter'd by the Prism, and yet could never be discover'd to exist in Light by any other kind of Torture?

We shall add, That if the Rays of Light are only separated by Refraction, and not Colours produc'd and made by such a Refraction, it would be impossible that the same Individual Rays should possess a greater Space after Refraction than before, without some intermediate Vacuities which are not acknowledg'd.

Moreover, the greatest Rays or the broadest Portion of Light, admits of the same different Refractions with the smallest, according to this Philosophy, w<sup>ch</sup> would be impossible, since *c* would be refracted into several distinct Rays in



*a*, and *d* into several in *b*, which would cause the utmost Confusion, whilst the whole Ray *c e f d* ought to be refracted in the same manner, with each of its Parts *c e, f d*.

Sir Is. Newt.  
Opticks Def. 1.  
Part. 1. Book 1.  
Prop. 2. Exp. 3.  
Book 1.

*That Secondary Refractions do not prove the Rays of Light differently refrangible in their own Nature.*

§. 40. The next sort of Experiments to prove the Rays of Light are differently refrangible, originally, and before their Primary Refraction, are such, as at the most demonstrate them only to be so afterwards, as those which are made by the Interposition of a Second or Third Prism, &c. which different Refrangibility will evidently follow upon the other Supposition likewise, namely, that Colours are various Shades of the same Homogeneous Light, which is weaken'd and impair'd, according to the several Oppositions it meets with, and by consequence must be differently refrangible, according to the different Force with which it is refracted.

§. 41. The

*The Kind of Experiments, and the Arguing from them made use of in Secondary Refractions.*

Sir II. Newt.  
Opticks Prop.  
2. Par. 1. B. I.  
Exp. 5, 6, 7, &c.

§. 41. The Chief Experiments of this Class, are to prove by several Instances of Observation, that the 2<sup>d</sup> or 3<sup>d</sup> Refractions, thro' Prisms plac'd behind one another, produce the same Effects with the first, and are subject to the same Laws; that is, let us vary the Positions of the Prisms, as we please, the Red Rays will always be the least refracted, and the Violet the most, which is thought to be a plain and unanswerable Argument, that there are certain Innate Properties of Light, as those of Colours, which do not depend upon its Transmission thro' the Prism; since, if the first Refraction thro' the Prism, was the Cause of any change in the real Affections or Properties of Light, by a Parity of Reason, a second Refraction thro' another Prism should obtain the same Effect, from whence fresh Phenomenons of Colours would result from every New Refraction.

*Against which Argument 1<sup>st</sup>, is from presuming what is to be prov'd, that Light is unalter'd in the first Refraction, because it is in the 2<sup>d</sup>.*

Arg. 2.

*From the Corpuscular Philosophy, being possibly understood, tho' not express'd, in the present Doctrine.*

§. 42. The Answer to which is, That if it cannot be prov'd, by the first Refraction, that Light is Heterogeneous in it self, the Arguments against which we have already explain'd, it cannot be evidenc'd from the second, unless it is presum'd for an undoubted truth, that if the first Refraction made a real Alteration in Light, the second ought to do it likewise; which is indeed presuming the very thing contested.

§. 43. 'Tis true, if there were differently figur'd Pores in Glass, and different kinds of Rays in Light, it would agree well enough with such an Hypothesis, to make some pass thro' one sort of Pores, and some thro' another, and by that Means oblige them to preserve the same Law in their being transmitted thro' a 2<sup>d</sup>, or 3<sup>d</sup>, or 4<sup>th</sup> Prism, from which last Refraction, if the Rays were trac'd back to the first, it would be found, by a plain Dependance of one refraction upon another, that the first proceeded from an Heterogeneousness of the Rays, and as this Philosophy is nothing else, but a Refinement upon the Corpuscular,

particular, it is not improbable, that the Foundation of the present Opinion, concerning the different Refrangibility of them, was deriv'd from it, and which therefore, as we have before shewn, there is good Reason to reject; we have also the juster grounds to surmise this, because there is an abundant use made of that Philosophy in explaining the Colours of Natural Bodies.

§. 44. However that is, it is very evident that the Laws of Action, betwixt two Substances as Light and Glass, are not fully determin'd, which it is necessary they should be, before we can peremptorily affirm, that if Homogeneous Light, supposing it to be so, is refracted into different Shades thro' a Prism, therefore those Shades thro' another Prism ought to be refracted into other different Shades, and so on; for since there are more Arguments for us to think, that the first Refraction occasions different Lights, than that Light is originally Heterogeneous, if there are 100 Experiments by Secondary Refractions to evince, that Heterogeneous Light is not from thence vary'd, they cannot in the least invalidate the Properties of the preceding; all that can be rationally concluded, is only this, that as the Arguments, drawn from the first Refraction, seem to evince Colours to be only various Shadows of Light, so the Experiments of the Secondary Refractions evince, that those Shadows, when once produc'd, are not to be alter'd, when they fall upon the same Medium and Figure of Glass, by the Intervention of which they were at first form'd.

§. 45. And the truth of it is, nothing can be more reasonable than to suppose this, that Shadows do not essentially alter upon every Refraction of the Prism, because where there is a Proportion of Action adjusted betwixt one Body and another, as betwixt Light and the Glass, thro' which it is refracted, it is not any ways irrational to conclude, that

Sir Is. Newt.  
Opticks Par. 3.  
Book 2.

Arg. 3.  
Because Secondary refractions can only prove the Heterogeneous Rays to be immutable after they are produc'd, but not before they are produc'd.

Arg. 4.  
That Light in its Transmission thro' several Glasses of the same kind, is not vary'd, and therefore not



*Colours thro' several Prisms.* that upon the Opposition of the same Figure and Medium, there shall no Material Alteration ensue. This is commonly experimented in Light, where, passing thro' 2 or 3, or more, small Lamellæ of Glass, it continues much the same, or at least without any Colours, or Heterogeneous Light being introduc'd into it, and therefore if it comes to be Heterogeneous by its Refraction thro' one Prism, it may continue so in its Transmission thro' another.

*Arg. 5.* §. 46. We must farther argue, that if Light is chang'd in its first Refraction, it is not necessary it should be in the second, which must be prov'd, *Because it is more rational to infer, that Light is Homogeneous before its first Refraction, from its being so after a second, in respect of the first, than from its being Homogeneous after a second Refraction, in respect of its first, to conclude it was originally Heterogeneous.* if what we have advanc'd is contradicted, on the other hand, which is the same, we must say, that if Light is not chang'd in its second Refraction, it is not necessary that it should not be in the first, which must be affirm'd, if what we oppose is certain, neither of which are agreeable to a just Reasoning; because, besides what has been already observ'd, it is more rational to infer, that Light is Homogeneous before its first Refraction, from its being so after a second, in respect of its first, which these Experiments only consider, than from its being Homogeneous after a second Refraction, in respect of its first, to conclude that therefore it was originally Heterogeneous: For it is evident in Fact, that the Refraction of the second Prism do's not cause those Alterations, which that of the first do's, the first changes Light into Colours, and the second barely propagates or continues them; how therefore a Propagation or a Continuation of Colours, from a second Refraction, should prove there was no Primary Alteration in Light from the first, is less intelligible or equally unintelligible, than how an Alteration of Light produc'd in the first Prism, should be deriv'd thro' the second without an Alteration.



§. 47. A Third kind of Experiments concern *A Third sort of Experiments*  
 the Uniting of the several Heterogeneous Rays *which unite co-*  
 together by a Lens, from which Conjunction a *lour'd Rays into*  
 Circle of Light on the opposite Paper succeeds, *Light, no Proof*  
 and is therefore suppos'd to be an invincible Proof *that Light con-*  
 that they were pre-existent in it before their Sepa- *sists of such*  
 ration by Refraction; and to confirm this, it is *Rays.*  
 said, that, if we mix several Powders together of *Sir Is. Newt.*  
 different Colours, a whitish Grey is produc'd, and *Opticks Prop.*  
 consequently we are told, it is reasonable to think, *§. Par. 2. B. 1.*  
 that Light is compounded of a like Farrago of  
 Dissimilar Rays, twisted and blended into one Uni-  
 form Appearance.

§. 48. As to the Producing of Light, from the *Arg. 1.*  
 Collection of the Heterogeneous Rays, by the *From the Na-*  
 means of a Lens, it is no Argument that Light *ture of the*  
 consisted originally, before its Refraction, in Rays *Lens changing*  
 of a different Colour, since it is the evident Pro- *Light into a*  
 perty of that Glass to make Light appear brighter, *bright Appear-*  
 when it converges to a Focus, than it did before *ance, and*  
 its Transmission thro' it; if therefore Colours are *therefore may*  
 Shades of Light, or Homogeneous Light alter'd, *do Colours into*  
 there is no more Difficulty to apprehend how an As- *Light.*  
 semblage of such Colours to a Point should be trans-  
 form'd into Light, than how Light determin'd to  
 a Focus should change into Brightness, without  
 either that Individual Brightness existing original-  
 in Light, or that Individual Light in the Colours,  
 which produc'd it, or which is all one, since the  
 Cause and Effect are reciprocal, without this In-  
 dividual Light existing in Brightness, or those In-  
 dividual Colours in the Light, exhibited from  
 them.

§. 49. What has been advanc'd in the foregoing *Arg. 2.*  
 Section, is upon the Supposition, that the Light *From the Solar*  
 which is Form'd by the Collection of the Hete- *Light's being*  
 rogeneous Rays to a Focus, thro' the Lens, is the *different from*  
 same kind of Light, which enters the Prism before its *that Light,*  
 refraction into Colours; for if it is different, there *which is form'd*  
 is *by the Collection*  
 of a Lens.

is another Argument against the present Conclusion from it, since the Collection of Colours into a different Light from that of the *Sun*, can be no Reason that the Light of the *Sun* is a Composition of them; but it is very manifest, that if we take a Piece of white Paper, and opposte it to the *Sun*'s Rays, the Light, which is reflected from thence, will have a different Appearance from that which is collected to a Focus, by the Transmission of Colours thro' a Lens, the one being Yellowish, and the other White; and it is plain, there is as great a Difference betwixt one Light and another, as there is betwixt Light and Shadow, and the same may be alledg'd in respect of the Grey or White Powder, produc'd from a Mixture of those of several Colours, since Grey or White are Appearances as distinct from that of the Solar Light as any the most different Colours can be from one another; from whence, I would hope, it follows, that it can be no good Argument, that all sorts of Colours go to the Composition of a Yellow, because all sorts of Colours go to the Composition of a White or a Grey.

Arg. 3.

*From the Dispersion or Shattering of the Rays not being necessary to the colour'd Image, and therefore not the Collection of 'em to reunite 'em into the Solar Light.*

§. 50. Besides which, the Reasoning from this Experiment of the Lens, collecting various Colours into one uniform Light, depends upon a Pre-supposition that the Rays are dispers'd and dissipated in their refraction thro' the Prism, and are again united by the Lens into the same Substance, out of which they were divided; against which there are two Objections; the 1<sup>st</sup>, that the several Orders of Colour are produc'd by a refraction of Light thro' the Prism, when the colour'd Image is no longer to appearance, than the Breadth of the refracting side of the Prism, and therefore a Dispersion of the Rays is not necessary to produce Colour, according to this Philosophy, which concludes such a Dispersion from the Length of the Image being increas'd, and which was the Foundation

dition of the present Doctrine. 2d, That if the Colours, refracted thro' the Lens, constituted the same Substance of Light, which they compounded before their Transmission thro' the Prism, the same Rays entering into the Composition of the one, which made up the other, must exhibit the same Appearance, and consequently not only display themselves into an enlighten'd Image of the same Complexion, contrary to §. 49, but of the same Capacity and Dimensions, that is, the Focus into which they are gather'd would be equal to the Side of the refracting Prism, by which they enter, or a small Circle to a Parallelogram, of a much greater Magnitude, which is impossible.

§. 51. It is farther urg'd, that from several Experiments Light and Colour may be compounded, so that if one Ray of the whole Composition is intercepted, they both degenerate into a Colour suitable to the Ingredient Rays which compound them. Thus Red and Yellow produce an Orange; Yellow and Green, a Colour betwixt both; Yellow, Green and Blue, a Green; to which if Red and Violet is added, the Green continues, but is less Vivid; and if the Red and Violet is increas'd, the Green changes to a White: Lastly, Red and Violet form various Purples, according to the different Proportions of their Mixture. So likewise, if the colour'd Image, projected by a Prism, is made to fall upon a Lens, and a white Paper receives the Rays transmitted thro' it, they will appear differently colour'd immediately behind the Lens, in the Focus white, and beyond the Focus differently colour'd again, only in an inverted Order, and when the Paper is plac'd in the Focus, and any of the colour'd Rays are intercepted at the Lens, the white Image will change into a Colour agreeable to the Rays, which enter into its Composition.

*The Change of Colours different, according to the different Composition of Homogeneous Lights.*  
Sir Is. Newt.  
Opticks Prop.  
4. Par. 2. B. 1.  
Sir Is. Newt.  
Opticks Prop.  
5. Par. 2. Book  
1. Exp. 9, 10.



Arg. 4.

*From the same kind of Colours being Homogeneous and Heterogeneous, or Simple and Compounded, it is reasonable to infer that there is an Homogeneous Light, or Uncompounded Light, as well as an Heterogeneous.*

§. 52. Granting therefore all that is desir'd, the Conclusion which follows from it is only this, that there may be a Light Compounded, as well as Colour; but as these Compounded or Heterogeneous Colours are acknowledg'd, in Fact and Experience, to be different from the Homogeneous ones, so it is likewise as certain that this Compounded Light is different from the Solar, and therefore we may reasonably infer, that the *Sun* has a Light Homogeneous and Constant to it self, as that the Homogeneous Rays have a Colour. For, besides the Analogy mention'd betwixt the one and the other, it is undeniable, that the Compounded Light diverges into Colours from the Focus, without any refraction, whereas the same Portion of the *Sun's* do's not, unless with it.

Add to this, that in these Compositions there is a great Latitude taken, so far, that Red and Violet mixt with Yellow, Green, and Blue, in a due Proportion, in §. 51, is own'd not to produce a White, but a Green and do's not change to a White, unless by a continual Increase of the former; whereas if Light consisted of Heterogeneous Rays of all sorts, whenever they were blended together, they ought immediately to constitute that Appearance, which, together with what has been produc'd in the foregoing Sections, will be sufficient to confute this Argument, which of all others seems the most plausible, and the most directly to affirm the Doctrine of Heterogeneous Rays in the Light of the *Sun*.

To conclude this Head, we do not deny a different Refrangibility or Action in the Colour'd Rays, which these Experiments only prove, but this we deny, that the Rays of the *Sun* were differently colour'd, or differently refrangible, before their Actual refraction, which I am certain they do not prove.

## C H A P. IV.

*Concerning the Modern Doctrine of the Prism, apply'd to the Solution of the Colours of Natural Bodies.*

§. 1. **T**HE Strange and Admirable Appearances produc'd by the Refraction of Light thro' the Prism, are but one sort of Phenomenons, which belongs to the true understanding of the Nature of Light and Colours; we shall now therefore proceed to inquire into the Application of this Philosophy to Natural Bodies, which seems to be rais'd and contriv'd upon a bare Contemplation of the Effects, resulting from the Refraction of a Luminous Substance thro' a Prism; but if it fails in this respect, that is, in the Application likewise to other colour'd Bodies, it will be a further Conviction of the Weakness and Invalidity of it; and indeed in the refracted Colours, and those of Body, the present Philosophy is nothing else than an Improvement upon the Prism of *Descartes*, and the Way he from thence took of explaining the several Colours in Nature, however absurd that Hypothesis is now acknowledg'd to be.

*The Doctrine of the Prism, if false, will be farther prov'd to be so, if it is not just in its Application to other Bodies.*

*Rohault Cap. 27. §. 65, 66, 67, 68, 69, &c.*

§. 2. The Colours therefore of Bodies are in the next place to be accounted for, from the Hypothesis of Heterogeneous Rays in the Light of the Sun, which, since we have already prov'd to be without any Foundation in the Truth and Reallity of Things, all the Consequences, which are drawn from it, to explain the Colours of Bodies, must be so too; notwithstanding, we shall at present suppose that this Philosophy has hitherto reason'd justly, and shall only require of it a Solution, from its own Principles deriv'd from the Prism, of the several Appearances of Colours, which occur to us in Natural Bodies.

*On the contrary, if the Doctrine of the Prism is false, whatever Consequences are drawn from it, cannot be true.*

*Granting yet the Doctrine of the Prism to be true, it do's not solve the Colours form'd by the Fancy or Imagination.*

Sir Is. Newt.  
Opticks, Prop.  
7. Par. 2. B. 1.

*Imaginary Colours ought to be solv'd, as well as others in a true Philosophy.*

*That Colours do not arise from different Terminations of Light and Shadow, is a Confutation of the Cartesian Account, but no Proof of the present.*

§. 3. That all Colours, in general, of Bodies, are made by the reflection or refraction of the Heterogeneous Rays of Light, is affirm'd by this Doctrine, excepting those which depend upon the Power of Imagination, as in Dreams, or a Phrensy, or when we see Fire by striking the Eye, or see Colours like those of a Peacock's Feather, by pressing our Eyes in either Corner, whilst we look the other way.

§. 4. As to the Exception of Colours, form'd by the Fancy or Imagination of our Minds, as it is not by this Philosophy determin'd what that Fancy or Imagination is, and as it must be acknowledged there is no Connection betwixt the Actions of the Mind, and those of the *Sun's* Rays, upon both Accounts it is evident, that the present Theory, which it is call'd, of Light and Colours, cannot give a Solution of those Appearances; whereas a true Theory of Light and Colours ought to be equal to all Solutions.

§. 5. However, omitting Imaginary Colours, as they are term'd, we shall now inquire, Whether, excepting them, which this Philosophy, without Reason, rejects, it can, from the Principles laid down of Heterogeneous Rays in Light, explain how all colour'd Bodies have that Appearance to us; which is thus endeavour'd to be prov'd, namely, because the Changes of Colours, made by Refractions, do not arise from any new Modifications of the Rays impress'd by those Refractions, and by the various Terminations of Light and Shadow; on the contrary, the first, as we have already evidenc'd, is not prov'd, that Colours do not arise from any new Modifications of Light; and as to the second, that they are made by the various Terminations of Light and Shadow, it is only the Affirmation of a Philosophy, which we do not take upon us to defend, since it has been already confuted.

§. 2. But



§. 6. But tho' this were manifest beyond Con-  
tradiction, namely, that the *Sun's* Light consists of  
Heterogeneous Rays, which have originally their  
several Refrangibilities and Colours, that is, altho'  
they were not new Modifications of Light, and  
could not be alter'd by any kind of Reflections or  
Refractions, it would not follow that therefore  
the Colours of Bodies are produc'd by the Inter-  
vention of such Rays, or because the Rays them-  
selves are unchangeably colour'd, that they are for  
that Reason Colorifick; unless it is impossible for  
a Thing to be, what it is, without communicating  
its Properties to other Beings, or Substances, di-  
stinct from it, and it is necessary, for Instance, be-  
cause Gold is yellow, that it should make Marble  
so.

Arg. 1.  
*Against the  
Doctrine of the  
Prism being  
applicable to  
Bodies: Be-  
cause what is  
colour'd is not  
always colori-  
fick.*

§. 7. Nor will it be sufficient in general to say,  
That if the Homogeneal Colours are cast successively  
upon Bodies, they put on that Colour with which  
they are illuminated, and therefore all Colours pro-  
ceed from such Illuminations; since tho' it should  
happen, that where the Red, or Blue, or any other  
colour'd Rays fall, such a Colour should always  
be preserv'd, it would not be from thence conse-  
quent that where-ever Red or Blue was, those  
Rays should be there to produce them; for it is  
no conclusive way of Arguing to infer, because  
there are certain Rays, which are immutably Red  
or Green, or Yellow, therefore the Red, or Green,  
or Yellow of all the Bodies in the Universe is  
deriv'd from that of the *Sun's* Rays; seeing, till it  
is otherwise proved, there may be an immutable  
connate Colour proper to Bodies, as well as to  
these Rays; and we may as justly affirm, that all  
Fluids owe their Nature to Water, because Water  
is fluid, as that all colour'd Bodies owe their Co-  
lour to the Heterogeneous Rays of Light, because  
the Heterogeneous Rays of Light are colour'd.

Arg. 2.  
*Because the  
Properties of  
Light, from  
their own do  
not infer the  
Existence of  
other Properties  
in Body, tho'  
Analogous to  
them.*

*The Instance of  
Cinnabar, and  
Ultramarine  
Blue, explain'd.  
Sir II. Newt.  
Opticks, Prop.  
10. Par. 2. B. 1.*

§. 8. It is notwithstanding urg'd, that if we take *Cinnabar* and *Ultramarine* Blue, and hold them together in an Homogeneous red Light, they will both appear of a red Colour, but the first will be lively and strong, and the latter of an obscure and duskyish Complexion; on the contrary, if they are held in an Homogeneous blue Light, they will likewise change into that Colour, but then the *Ultramarine* will look bright and resplendent, and the *Cinnabar* faint and dark; from whence it is collected, that red Bodies reflect Rays of their own Colour more copiously than those of a different, and that the same may be affirm'd of Blue, and the rest; and consequently, since Light consists of Heterogeneous Rays, the Reason why Bodies appear to us with varying Colours, is, because they reflect one kind of Rays in a greater plenty than another, by which means the Body is seen in that Colour of the Rays, which it is the most capable of returning to the Eye.

Arg. 3.

*That two differently colour'd Bodies, held in the same Homogeneous Light, no Proof that the Colours of Bodies proceed from their more copiously reflecting one sort of Rays, rather than another.*

§. 9. The way of Reasoning made use of here is very large and profuse; for in the first place, it is not certain, that, because Red Bodies, in a Red Homogeneous Light, appear the most resplendent, and other Bodies, as Blue, in the same Homogeneous Light, are less bright and vivid, it is not necessary from thence, that Red Bodies should reflect the most Red Rays of the *Sun*, distinct and abstracted from their own Red or Blue, which they emit; since there may be an equal number of Red Rays of the *Sun* reflected from both the Red and the Blue Substance, and yet the proper Rays of each Body mixing with them may cause very different Appearances; that is, the Red Rays of the *Sun* mixing with the Red Rays of the Body may produce an Intense Red, and the same Red Rays of the *Sun* mixing with the Blue ones of the Body may constitute a very faint one, when yet the Red Solar Rays, which are cast from the Homogeneous Light, may be equally reflected from both Bodies. It

It is evident from the Composition of Homogeneous Lights, that, by various Mixtures of them, differing Colours are form'd, and that, if one Red is added to another, there is an Increase of it, but if the same Red is joyn'd with other Colours, it becomes diluted and languid, or perfectly transform'd into a different, in Proportion to the Action of the Compounding Rays; it is therefore inconceivable, how that should be made an Argument for the Reflection of one sort of Rays in particular, which is only a Proof of the different Mixture of several, or how we should come to know that Red or Blue Bodies reflect Red and Blue Rays the most plentifully, because a Red and a Blue, mixt in one Case or the other, produce a fainter Red or Blue, than when Red or Blue is united with its own Colour, supposing the Bodies themselves have any Power of Producing Red or Blue Colours to our Sight, independent of Heterogeneous Rays, which this Philosophy is to confute, and which can never be done by presuming it.

§. 10. Nor will this Argument be confirm'd by Arg. 4<sup>th</sup> saying, that Red Rays falling upon a Blue Substance produces a Red, and Blue Rays upon a Red, a Blue, and therefore that nothing is to be here consider'd, to determine the Colour of each, but the Impingent Homogeneous Light, and the Bodies which reflect them, with their various Capacities of Reflection; since, on the contrary, it is own'd, that Red Rays falling upon a Blue Substance, do not produce the same Red, as when they are reflected from a Red; and consequently, if from the Obedience and Passiveness in Bodies, to receive the Colour, which is projected upon them, from the Homogeneous Lights, we may conclude the absolute and independent Efficacy in those Lights of causing such Colours, from the Obstinacy and Power in Bodies, of varying the same Colour, when projected on different ones, we may as rationally

*Differently colour'd Rays falling upon the same colour'd Substance, no Proof that its Colour is deriv'd from them, tho' they change it into that Colour.*



Arg. 5.

There is no  
Comparison  
betwixt the A-  
five Colours of  
the Sun, and  
the more faint  
and languid  
ones of Bodies.

infer their Part or Share also in exhibiting them.  
§. 11. Besides, it is notorious, that Lights by their Activity and Quickness are sooner seen and discern'd, than the Actions of any other Bodies, and therefore, tho' the Blue or Red of a consistent Substance is not so visible, as that which is deriv'd from the *Sun*, it will not from thence follow, that it had no Blue or Red Colour Originally of its own, but what it receiv'd from such kind of Homogeneal Lights as are here imagin'd; thus the Light of the *Sun* will be able to extinguish that of a Lamp, but it will not be certain, upon that Account, that the Lamp had never any Original Light belonging to it.

Arg. 6.

That this Do-  
ctrine takes for  
granted what  
should be  
prov'd.

§. 12. Lastly, if it is said, that it is Matter of Fact, that there are more Red Rays reflected from a Red Substance than a Blue, without distinguishing betwixt those of Homogeneal Light, from the Red or Blue ones of the Bodies, on which they fall, and if from thence it is concluded, that there are more Red Solar and Homogeneal Rays reflected in the one Case than in the other, this Doctrine takes for granted what remains in Question, whilst it computes into the Number of the Solar Lights, those which are at present suppos'd, at least till the contrary is evidenc'd, to be deriv'd from the Substances themselves.

Arg. 7.

From Bodies not  
being colour'd  
by the Rays  
of Light, even  
according to the  
Experiments of  
this Philosophy.  
Sir I. Newt.  
Opticks Prop.  
10. Part. 2.  
Book 1. Expe-  
riment 17.

§. 13. The Mistake which this Philosophy has been guilty of, in the present Doctrine advanc'd, is farther evident from the imperfect Account it gives of several Experiments, against one it has made choice of to defend, and which it endeavours to solve, by only telling us, the Variety of their Appearances proceeds from the Prismatick Colours, being not sufficiently Homogeneal: Thus Red Lead, illuminated with the Ordinary Prismatick Green, will not appear either Red or Green, but Orange or Yellow; and the like happens in divers other Colours, where the Homogeneal Lights of the *Sun*,

pro-

projected upon colour'd Bodies, do not produce the Colour of the Rays projected, which it ought to do, according to the Experiment recited in the 8<sup>m</sup> §, but a Colour compounded of that of the Homogeneous Light, and the Body it illuminates; for whatever the Prismatick Colour is made up of, the Colour, not the Ingredients which form it, is only to be consider'd in the present Case.

§. 14. But granting this were true, that colour'd Bodies, for the Reasons alledg'd, reflect the Rays of its own Colour more copiously than others, this yet would not suffice for the Solution of the Colours of consistent Bodies, unless it was originally suppos'd, that the Rays of the *Sun* are complicated of Heterogeneous Lights, since if they were not, how Bodies, which consist of Homogeneous Matter, should be Red or Blue, or of any other Colour in the Light of the *Sun*, which is Homogeneous, no one can, I believe, comprehend; and, as it has been before prov'd, there is not the least Foundation for that Doctrine, there can be no more for this.

§. 15. If yet all this was allow'd, it would still be unaccountable, which way we perceive Colours in Bodies by the Light of a Fire, or a Lamp, or a Phosphorus; if it is said, the Light of Fire, &c. is of the same Nature with the *Sun's*, it is not to the purpose; for if the Rays of a Lamp, or a Fire, are not the Individual Rays of the *Sun*, how the Colours, which are cast from them, should be explain'd by the Individual Rays of the *Sun*, whose Properties and Degrees of refrangibility this Philosophy only considers, will be hard to determine.

§. 16. But tho' we should resign the utmost Latitude of Reasoning to this Philosophy, and own, that if the Light of the Fire, or a Lamp, &c. and the *Sun* are of the same Nature, all kind of Colours are very well accounted for, by the Properties of the *Sun's* Rays only, yet it will not be a little

Arg. 8.

*That, unless Light was originally suppos'd to be Heterogeneous, it would be impossible to prove that Homogeneous Matter receiv'd its Impressions of Colours from it.*

Arg. 9.

*From Bodies being seen colour'd by the Fire, or a Phosphorus, where no Rays of the Sun can possibly intervene.*

Arg. 10.

*From the Rays of the Sun, and a Lamp, producing different Colours in the same Body.*

little unfortunate to this celebrated Theory, if, after so large a Concession, they should not be of the same Nature, as indeed they are not; for it is manifest from Experience, That that which is Blue from the Rays of the *Sun*, by the Light of a Lamp, or Fire, sometimes appears to be Green, Red looks like Orange, and Yellow approaches to a White, as in Silks and Mettals, and those Bodies, which have a peculiar Radiancy and Glossiness in their Colours, which would be impossible, the several colour'd Bodies continuing the same, if the Rays of the *Sun*, and those of a Lamp, or a Fire, were not of a different Complexion.

Arg. 11.

*That this Hypothesis of Colours gives no Solution of the most common and vulgar we perceive, as those of Clay, Earth, &c.*

*Bohault Cap. 26. Par. 1.*

§. 17. More than this, that which seems to be another Objection against this Hypothesis, is, that, at the best, it can only give a Solution of Colours, which are the more Bright and Flaming, as Red, Green, Blew, Yellow, Violet, and the several Compositions which are made from them, whereas the more base and abject, of Wood, Earth, Sand, Clay, &c. are not thought worthy of a Consideration; for let us compound and decompound the Rays of Light as we please, none of these Colours will result from them: The Assertors therefore of this Doctrine seem to have us'd the same Artifice with those Philosophers, who have endeavour'd to explain Sound; who by descanting upon the Notes of a Harp, or a Violin, would make us believe they have given us a Notion of the dead Sound of Lead, or the Explosion of a Mortar; but it is too plain, to any one who considers the real Forces of Nature, that we may as well chuse the last to explain the former, as these the other, unless we are willing to contrive a pretty Entertainment for the Mind, by leading it into Inquiries, which shall rather please and delight, than furnish it with any True and Rational Knowledge of Things; and in truth, our Make and Constitution is such, that we are apter to be perswaded into gilded



gilded and diverting Errors, than to embrace the Plainest and most notorious Truths, where they are not recommended with the like gay and flashy Appearance; for it is, in a great measure, the same Case with the Modern Philosophers, as with the Poets, who select the most agreeable Images, to strike on our Fancies, rather than the most accurate and just, to inform our Understandings.

§. 18. There is, however, an Argument made use of in Patronage of this Doctrine, which has been already consider'd in §. 4, 5, 6, &c. Chap. 3. namely, the Experiments of two Pieces of Pastboard painted, the one w<sup>th</sup> Red, and the other with Blue, and which is thought to be an absolute Proof that differently colour'd Bodies reflect Rays, which are differently colour'd and refrangible, and therefore, from thence it is immediately concluded, that those Colours are owing to the Rays of the *Sun*, being differently colour'd and refrangible, before their incidence upon the Bodies from which they are reflected; which is not certain, unless upon this Supposition, that Bodies, by Reflection, cannot in the least change the Colour of the Rays of Light that fall upon them, and which, in the last resort, comes to an Affirmation of what we have been hitherto confuting, *viz.* That Matter is Similar and Homogeneous, and is made up of nothing but the Original Qualities, as they are presum'd, of Solidity, Figure, and Extension. This therefore is first to be prov'd, before such a Demonstration, as the present is thought to be, can be of any Force or Significance.

Arg. 12.

*From the Experiments upon Pastboard, which can be of no significance, unless Matter is Similar and Homogeneous.*

§. 19. On the contrary, that Bodies have a power of changing the Rays of Light, which fall upon them, is evident, even from those Experiments which are made use of, and defended as Fundamental to this Hypothesis; for in §. 8. *Cinnabar* and *Ultramarine* Blue change the Appearance of the Homogeneous Light of Red and Blue, the one

Arg. 13.

*From the Inconsistency in this Doctrine, betwixt §. 18. and 8.*

exhi-

*Other Arguments against this Doctrine consider'd.*

*The next thing which wants an Explanation, is the Capacity in Bodies, by which they are made to reflect the Heterogeneous Rays of Light.*

*No Proper Qualities in Bodies to change the Colours of the Incident Rays, own'd by this Philosophy.*

*Different Figures, or Pores in Bodies, no Solution of the various Capacities in them to reflect differently colour'd Rays.*

exhibiting a bright resplendent one, and the other a dark and obscure, which shews the strange Inconsistency of the present Account of Light and Colours, since in §. 8, it is suppos'd necessary to the truth of it, that the Homogeneous Colours of Light should be chang'd by the Bodies on which they impinge, and in §. 18, that they should not.

§. 20. However, since the present Theory seems to be conscious, that this must be at last affirm'd, that there is a Capacity, in reflecting Bodies, of changing the Appearances of Colours to us, and therefore only wants to contrive an Hypothesis to that end, which may be consistent with the previous one of Heterogeneous and Immutably colour'd Rays in the *Sun*, we shall now consider what Advantages it has made with this Purpose and Design.

§. 21. And first it is plain, that any Proper and Original Qualities in Bodies to change the Rays of the *Sun*, when suppos'd to be Homogeneous, will not serve this Philosophy; because if they could do that, there would be no Reason to prepare the *Sun's* Light before-hand into Colours, and leave it only to Bodies to reflect them: And if it is prepar'd into Colours, by supposing it to consist of Heterogeneous Rays, the only Province assign'd to Bodies, is to reflect the Rays, which are incident upon them; the Difficulty therefore lies here, which way it comes to pass, that certain Bodies reflect only one kind of Rays, and others another, with the greatest Distinction and Choice, and the most peculiar Obstinacy that we can imagine.

§. 22. If it is affirm'd, as in the Corpuscular Philosophy, that Bodies consist of variously figur'd Parts, and consequently of different Pores; that might possibly be a Reason why fewer or more Rays of the same Colour or Nature, should be reflected from such Bodies, but could not be any, why Red or Blue Rays, for Instance, are reflected more from one Body than another; since there is no

Con-

Connection betwixt a Triangle, or a Square, or a Circle, or a Polygone, or any other Figure, and Red or Blue, or Yellow, &c. so that one Figure should necessarily reflect one Colour, and another one that is distinct from it; or which is the same, Colour and Figure, in general, can no more mutually infer each other, than Figure and Sound, or Sound and Colour, unless there can be some Principle found out, which shall be the united Cause of them, and which can joyn and connect them together, by an immutable Dependence and Coherence.

§. 23. The way therefore insisted upon to prove, that Homogeneous Matter may reflect Heterogeneous Lights, is by proposing, that those Surfaces of Transparent Bodies reflect the greatest Quantity of Light, which have the greatest refracting Power, that is, those Surfaces of Transparent Bodies, which intercede or lie betwixt Mediums that differ most in their refractive Densities; and in the confines of equally refracting Mediums, there is no Reflection; the first Part of this Proposition seems at present plain, from this Consideration, that when Light passes obliquely out of one Medium into another, which refracts from the Perpendicular, the greater the Difference is of their refractive Density, the less Obliquity is requisite to cause a total Reflection; thus in the passing of Light out of Water into Air, the total Reflection begins when the Angle of Incidence is about 48 Degrees and 35 Minutes, in passing out of Glass into Air, when the Angle of Incidence is 40 Degrees and 10 Minutes, and so in passing out of Chrystal, or more strongly refracting Mediums into Air, there is still a less Obliquity requisite to cause a total Reflection; from whence it is manifest, that those Surfaces which refract most, do soonest reflect all the Light which is incident on them, and this is confirm'd from other Experiments. The Second Part of this Proposition is likewise prov'd

*The Denfor any Mediums are, the sooner they reflect the Incident Rays.*

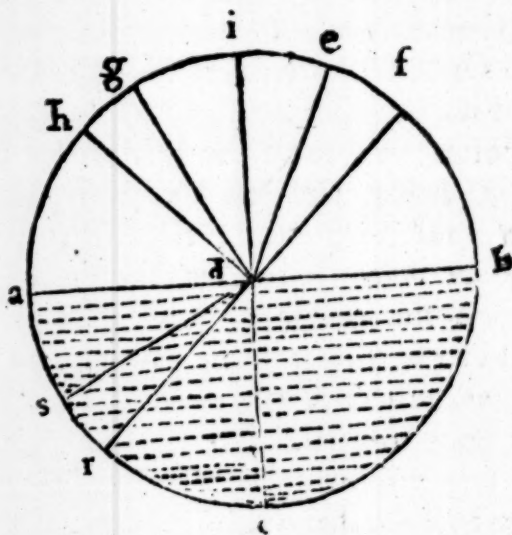
Sir H. Newt. Opticks Prop. 1. Part. 3. Book 2.



prov'd from Glafs, which may be consider'd, as divided into different Plates or Laminæ, in which as there is no different Refraction, so there is no Reflection.

*From the foregoing Section, it would only follow, that Denser Bodies would be more Luminous, not that they would reflect different Colours from others.*

§. 24. Let us therefore suppose the whole of this to be true, for we do not, at present, professedly inquire into the Mutual Actions of Bodies, whether of Glafs or Chrystal, or Water, or Diamonds, or Sal Gemme, or Metaline Glasses, or Island Glasses, or white-transparent Arsenick, all which are made use of on this occasion, we do not now examine into their Actions, in their Comparison with, or Relation to Light, since we have resign'd that to another Part of the Principles of Natural Philosophy: Let us, I say, suppose the whole of this to be true, there can yet be no Consequence drawn to prove, that the permanent Colours of Natural Bodies are owing to the bare reflexive Quality in them, in sending back such certain Rays to the Eye, and transmitting, or some way or other sti-



fling the rest; for all that is demonstrated here, is only, that if the Medium *abc* resists more, the Inclination of *ed* to *id* needs to be less, to make a total Reflection to *dg*; if the Medium *abc* resists less, the Inclination of *fd* to *id* must be greater,

greater, to produce a Reflection to  $dh$ ; which is very evident and plain, because the refracted Ray  $ds$  approaches nearer to  $da$ , in the first Case, than  $dr$ , in the second, and consequently  $ds$  will sooner rise out of the refracting Medium than  $dr$ , that is, will be sooner reflected; so that where the Medium is denser, there will be reflections from more Incidences, namely, from all the Rays which lie betwixt  $e$  and  $b$ , and where the Medium is rarer, there will be Reflections from fewer, to wit, from those Rays only which fall betwixt  $f$  and  $b$ ; the Inference from which Premises is this, and nothing more, that a denser Body ought therefore to be more Luminous and Bright, and a rarer less so, but no one can by any imaginable way of Reasoning deduce, that one Body or Medium should therefore reflect Rays of one Colour, and another Medium those of another, because one reflects more Rays of the same Colour and Complexion than the other; nor do's this Proposition, by what I can at present apprehend, in the least prepare us for such a Conclusion.

We shall farther add, that if  $ed$  is expressive of the incident Rays, and not  $ed, fd$ , and the Refractions of different Mediums, are represented by  $ds, dr$ , a denser Body will not be more Luminous than a rarer, but both equally so; since all the Incident Rays betwixt  $e$  and  $b$  are suppos'd, in such a Case, to be reflected from  $d$ ; what therefore this Proposition can signify to the Explaining the Reason of Bodies, reflecting differently colour'd Rays, we do not again understand.

§. 25. A second Proposition, in order to establish the present Doctrine, is, that the least Parts of almost all Natural Bodies are in some measure transparent, and the Opacity of those Bodies arises from the Multitude of Reflections caus'd in their internal Parts: The first Part of this Proposition is endeavour'd to be prov'd, but the last is not so much as aim'd at;

*The least Parts of Natural Bodies are asfirm'd, in this Philosophy, to be transparent, and their Opacity is caus'd*

from their internal Reflections.

Sir Iſ. Newt.

Opticks, Prop.

2. Par. 3. Book

2.

\* The least parts of Bodies not prov'd to be transparent.

at; and yet, if they both were demonstratively clear, there would be nothing evinc'd, which could in the least favour the Hypothesis of the Heterogeneous Rays of Light.

\* §. 26. That the least parts of almost all Natural Bodies are in some measure transparent, is affirm'd, and therefore by the Terms *almost*, and *in some measure*, is own'd to be true only in a Quality'd Sense, and cannot be extended to *all* Natural Bodies, nor yet to all those small Parts of them, which are said to be *in some measure* transparent; if then by this Proposition it is acknowledg'd, that there are Bodies, whose least Parts have a certain kind of Opacity in them, to what purpose can it be alledg'd to prove, that all Opacity proceeds from the Reflections of Transparent Parts, when, in some Opaque Bodies, there are confessedly no Transparent Parts that can be discover'd by any Methods, and in others, where the least Parts are *in some measure* onely Transparent, there yet is an evident Opaqueness?

However, tho' this Demonstration cannot convince us, we shall afterwards in our Principles of Philosophy shew from Reason, that in another Sense the minutest Parts of all Natural Bodies must be Transparent, which can never be prov'd from any thing mention'd in this Proposition, or the Arguments us'd to perswade us of the truth of it, since white Metalline Bodies are excepted, and are confess'd to reflect the chief Part of their Light from their first Superficies; for there is no more Reason why the Opacity of white Metalline Substances should be explain'd from the Transparent Parts, observable in other Bodies, than why the Transparency of the Parts of other Bodies should not be explain'd by the Opacity of these, till some Original Principles are laid down, by which Opacity and Transparency may be explicated; it being certain, that a Transparent Body may as well consist

of



of Opake Parts, as an Opake of Transparent; for, to the naked Eye, Glass may as well be powder'd into an Opake Substance, as Gold divided into a Transparent Blue one, and therefore if Glass were made to magnify so far, as we might see the infinitely small Parts of all Bodies, and, if I may so call them, the last Atoms of 'em, how are we any more sure that they would not appear Opake, than we are that they would Transparent, before we know the Causes of either? Besides (which is the chief Argument that is us'd) it is not evident that Microscopes do not impress a Transparency upon Objects, which we view thro' them, when yet those Objects might not be Originally possess'd of any such Quality; for why they should increase the Magnitude of Objects, and not the Light of them, will be difficult to say; or why Bodies should not look Brighter and more Transparent thro' a Multiply'd Light, as well as Colour'd, and Shaded thro' a refracted, or diminish'd.

§. 27. Having consider'd the Constituent Parts of Bodies, and how arbitrarily the present Philosophy assumes their Transparency for granted, let us now suppose that the least Parts even of all Bodies were Transparent, and inquire, Whether from thence we are let into any Knowledge of what Opacity is, which is said to arise from the Multitude of Reflections caus'd in their Internal Parts; with what Satisfaction might we believe this, if there was the least Argument produc'd to confirm it? But when there is not one word offer'd to persuade us it is true, we cannot but think, that this Philosophy wisely prefer'd its Authority to its Reason; for what can be meant, or intended by this *Imaginary* Multitude of Reflections? If they are towards the Eye, what is it possible for them to produce but Brightness? if from it, Darkness? if it is a confus'd Reflection within the Internal Parts of the Body it self, which never reaches the Eye,

*The Opacity of Bodies cannot proceed from a Multitude of Internal Reflections.*

*Arg. 1. Because at the most they could only cause a Diminution of Light.*

it will have the same Effect; if a direct Reflection of the Rays to the Eye is impair'd and diminish'd, by the confus'd and transverse ones of the Internal Reflections, it will give us a more faint and languid Impression of Light; but as Brightness is differing from Transparency, and Darkness from Opacity, so is any Intermediate Degree of either; and consequently this Account can give us no true Notion of what is meant by Opacity, which is the same, whether any Body is black or white, or of any Colour we can imagine.

Arg. 2.

*Because this Account of Opacity depends upon the truth of the Corpuscular Philosophy, which is not evidenc'd.*

§. 28. Besides which it is plain, that this Account depends upon the Corpuscular System, which should be better evidenc'd than it is, before we are desin'd to acquiesce in Propositions that rest upon it, and which, by that Modern Term, is always suppos'd to include a Demonstration; and it is for that Reason that I call these Reflections *Imaginary*; for if we consider Bodies as consisting of the same kind of Substance, and (allowing for some vacant Interstices, which are of no Moment or Consideration, in respect of the Bodies, which they pervade,) of the same Homogeneous Nature, all these Tumultuary Reflections, contriv'd on purpose to serve an Hypothesis, will vanish, and be as unreasonable and absurd, as if, in giving an Account of the Weight of Gold, we should take abundance of Pains to compute into its Substance, that of the refin'd Matter it may be suppos'd to inclose, and which do's not enter into the Nature or Essence of it; and it would be as unreasonable, in such a Case, to make Opacity depend upon Pores Heterogeneous to the Body, especially when even this Philosophy owns Prop. 1<sup>st</sup>, that Reflections or Refractions are not different, if there is the same kind or Density of Substance.

*If this Account of Opacity was true, it would be of no service*

§. 29. If yet what we have hitherto disputed were certain, what Advantage would this be to the suppos'd Theory of Light and Colours? For if Opacity

Opacity arises from an Internal Constitution of the Body, let the Cause assign'd be what it will, as here it is presum'd to be a Multitude of Reflections, the Effect will still be such, as not to have been Originally in Light, but *de novo* produc'd in the Body it self, whereas Colours are suppos'd to be previously in Light, to their Reflection from Bodies; how therefore this Doctrine of Opakeness, which depends upon a Confession of its being form'd and fram'd out of Light, by the mere Force of Reflection, which Opakeness was not inherent in Light before, should lead us into an Apprehension that Colours of Bodies are likewise made out of Light by Reflection, which Colours were inherent in Light before Reflection, will be a Problem in this Philosophy too intricate to explain.

§. 30. A Third Proposition is, That between the Parts of Opaque and Colour'd Bodies are many Spaces, either empty, or replenish'd with Mediums of other Densities, as Water between the Tinging Corpuscles, wherewith any Liquor is impregnated, Air between the Aqueous Globules that constitute Clouds or Mists, and for the most Part Spaces void of both Air and Water, but yet perhaps not wholly void of all Substance, between the Parts of hard Bodies. The Meaning of this Proposition seems to be nothing else, than to confirm the Second, in respect of one Objection, which might be made against it, drawn from what was affirm'd in the First, That in the Confines of equally refracting Mediums there is no Reflection, and which was taken notice of in §. 28, where we said, there was no more Reason to perplex Philosophy with the small Interstices of Bodies, in order to ascertain their Opacity, than to compute the Weight or Properties of such Vacuities into the Nature of Gold.

§. 31. But since, as we have reason to believe from Prop. 1, that there must be a particular Stress laid upon the vacant Spaces to confirm this Theory, and

*to explain how the Colours of Bodies proceed from Heterogeneous Rays of the Sun.*

*It is farther affirm'd in this Philosophy, that all Bodies which are colour'd, or opaque, contain Interstices of a different Substance from their own.*

Sir Is. Newt. Opticks Prop. 3. Par. 3. B. 2.

*The foregoing Section not prov'd, but by supposing what*



was to be demonstrated.

and since we now find it is so important a Point, as to be made into a Proposition by it self, we shall therefore here more fully examine into it; The Way that is taken to prove it true, is, because by Prop. 2*d*, there are many Reflections made by the Internal Parts of Bodies, and by Prop. 1*st* those Reflections could not be made without Interstices of a different Substance, that is, without Superficies, which intercede Mediums of differing Density; whereas Prop. 2*d*, in respect of the many Reflections there asserted, by what was affirm'd in Prop. 1*st*, depended upon that which is now alledg'd in Prop. 3*d*; and therefore to prove this 3*d* Prop. by the 1*st* and 2*d*, which depended upon it, is the same as to prove the 1*st* and 2*d*, so far as they relate to the present Case by the 3*d*, which is a Circular way of Arguing, and not in any Manner agreeable to a Mathematick Reasoning.

*This Account of Opacity not confirm'd from Bodies becoming transparent, by filling up their Pores with a Matter of the same Density, &c.*

Sir I<sup>s</sup>. Newt.  
Opticks Prop.  
3. Part. 3.  
Book 2.

§. 32. To support this 3*d* Proposition, it is farther added, that the Discontinuity of Parts is the Principal Reason of Opacity, because Opake Substances become transparent, by filling their Pores with any Substance of equal or almost equal Density with their Parts: Thus Paper dipt in Water or Oyl, the *Oculus Mundi* Stone steeped in Water, Linnen-Cloth, Oyl'd or Varnish'd become transparent; on the contrary, the most transparent Substances, by evacuating their Pores, or separating their Parts, may be render'd sufficiently Opake, as Salts or wet Paper, or the *Oculus Mundi* Stone, by being dry'd, Horn by being scrap'd, Glass by being reduc'd to Powder, Turpentine by being mixt with Water, and Water by being form'd into small Bubbles, as in Froth; But that neither Opacity nor Transparency can be prov'd to arise from the Causes assign'd by these Instances, is evident, if we consider, that tho' the Parts of Oyl and Water, and the other Substances were of the same Density, or Weight with the Bodies, whose Pores they are to replenish (which they

they are not) yet, since they are acknowledg'd to be of a different Nature from them, the Parts of Water, or Oyl, for Example, from those of Paper, the one being a Fluid, and the other a Solid, till it is known whether a Mixture of two such different Natures may not produce a Transparency, from their mutual Energy and Force upon each other, in the same manner as an Acid raises a Precipitation into a Transparency, and not by barely filling the vacant Pores, it will be no sufficient Argument to convince us of the truth of such a Proposition. Thus, on the other hand, Water and Turpentine produce an Opakeness, as several Coagulums in Chymistry do; but to affirm all these Coagulums proceed from evacuating the Pores, will be a high Offence against the Maxims of the Philosophy, upon which the present is founded, since that professes they are caus'd by a Repletion of them, and by an Entangling of the Parts, not by a Disengaging of them.

Rohault, and Lemmery.

§. 33. That which makes this kind of Reasoning still more uncertain, is, that in one Part of it, the uniting of Parts together is made necessary to Transparency, and the Separating of them to Opacity, whereas a hundred Instances may be brought to prove the contrary, even by the Acknowledgment of the 2<sup>d</sup> Prop. which says, That almost all Bodies in their ultimate Parts are transparent, which yet, united, are evidently Opake, and indeed if there was nothing more necessary in the inward Temper and Constitution of Bodies to produce Transparency or Opacity, than their exact Conformation of Parts to each other of the same Density; those Bodies which are the least porous ought to be the most transparent, which is so extravagant an Hypothesis, from whence so absurd a Conclusion follows, that we can scarcely think it deserves any farther Consutation.

*If Transparency depended upon a Repletion of the Pores with Matter of the same Density, the most full and consolidated Body ought to be the most transparent.*

*On the contrary, Bodies divided into the smallest parts would be the most Opake.*

§. 34. And as this Conclusion would follow, that the most compact Bodies should be the most transparent, so there would another Absurdity ensue from it, that Bodies divided into the minutest Parts would be Opake; which is as repugnant to a hundred Experiments as the other, according to the Notions of the Corpuscular Philosophy, which supposes that all Bodies dissolv'd in their proper Menstruums, is only a Division of the Parts of that Body, and therefore Dissolutions should be Opake, when yet they are found to be Transparent.

*That the Parts of Bodies must not be less than of a certain definite Bigness to produce Opacity affirm'd, because necessary to the present Hypothesis that they should not.*

Sir Is. Newt.  
Opticks Prop.  
4. Part. 3. B. 2.

§. 35. In order therefore to ward against this Difficulty, a 4th Proposition is contriv'd, that the Parts of Bodies, and their Interstices must not be less than of some Definite Bigness to render them Opake and Colour'd; because the opakest Bodies, if their Parts be subtilly divided, as Mettals, by being dissolv'd in Acid Menstruums, become perfectly transparent; that is, because the Dissolution of hard or Opake Bodies in transparent Ones, is an Objection against this Doctrine of Opacity, proceeding from the Division of the Parts, therefore it is assum'd as necessary, and it is by this Proposition pronounc'd to be so, that those Parts shall be only of a Definite Bigness; against which we likewise pronounce, That since the Division of the Parts of Bodies from one another is own'd to be a Cause of their Opacity, either it is without restrictions, or it is not; if it is without restrictions, there is no occasion for the present Proposition; if it is with, those Limitations ought to be explain'd from Reason, and not Matter of Fact; because, unless that Matter of Fact is explain'd from the same Principles of Philosophy, it is so far from confirming such a Philosophy, that it do's and will lie as an Objection against it.

*The Instances of the Object Glasses being near, and of the Water Bubble*

§. 36. We need not consequently examine into what we are remember'd of, that in certain Observations made, there was no Sensible Reflection at the Superficies of the Object Glasses, where they were



were very near one another, tho' they did not absolutely touch, or that the Reflection of the Water Bubble, where it became thinnest, was almost insensible, since if the present Hypothesis of Opacity contradicts, or do's not solve the known Phenomenon of the Dissolution of Bodies in Acid Menstruums becoming transparent, unless by a new Supposition of Parts of a Definite Bigness, it cannot account for these particular Observations, no more than for Water, Salt, Glass, or Stone being transparent, where their Pores are probably more, and their parts less than in other Bodies, and therefore their Internal Reflections; for it is impossible in Reason, that the Smalness of the Parts of Bodies should diminish the number of Reflections of Light in them, since the less the Parts are, there must necessarily be the more Reflections from them; and altho' the nearness of one Part to another, by the Instance of the Object Glasses, is here made a Reason, why there should be no Reflection, and therefore no Opacity in the same Corpuscles of the dissolv'd Body, yet in white Metalline Bodies, which are suppos'd to consist of small transparent Parts, and which must be much nearer to each other than the Object Glasses mention'd, it is thought Reflections may be well enough perform'd, so as to produce Opacity.

§. 37. That which we shall therefore farther observe, upon these two last Propositions, is only, that when the two first began with giving us an Account of Opacity, the two last have joyn'd Colours with it, as if they stood and fell upon the same Principles; and if so, it is evident, that whatever has been objected against this Account of Opacity, equally obtains against Colours, and consequently, that the present Theory cannot explain to us what the Reason of Bodies being colour'd is, even upon the Supposition of Heterogeneous Rays in the Sun's Light.

*when thinnest, nor reflecting, or insensibly reflecting the Rays, of no significance to the present Doctrine of Opacity.*

*Since Opaque and Colour'd Bodies are endeavour'd to be solv'd by the same Hypothesis, what has been objected against Opacity is equally conclusive against the Solution of Colours in Bodies.*

*That different-  
ly colour'd Bo-  
dies consist of  
Particles, which  
resemble the  
Fragments of  
thin Plates of  
Glass, of differ-  
ent Thinnesses,  
consider'd.*

Sir Iſ. Newt.  
Opticks Prop.  
5. Par. 3. B. 2.

§. 38. This Philosophy, notwithstanding, proceeds to a 5th Proposition, to prove that the Transparent Parts of Bodies, according to their several Sizes, must reflect Rays of one Colour, and transmit those of another, for the same Reason, that Thin Plates or Bubbles do reflect, or transmit those Rays; and this is taken to be the Ground of all their Colours; that is, all Bodies are thought to consist of a Congeries, or heap of Pellucid Parts, like the broken pieces of Plates of Glass, each of which have the same Colour with the whole Mass or Congeries, because if we break or divide a colour'd Glass Plate into several Fragments, such a Division will not produce any Alteration in the Colour of the Plates. And as to the Colour of each Part, that is determin'd by the Thickness or Thinness of the Plate, to the Fragments of which the small Particles of Natural Bodies are made Analogous: The truth of it is, this is so curious and refin'd an Hypothesis, that tho' we had a multitude of Reasons to convince us of the reality of it, yet it looks so much like a Fiction of the Mind, and takes so many affected Turns and Doubles to ensnare us into a Perswasion of its Certainty, that a sincere Inquirer into Nature would scarcely be induc'd to believe it: But when, on the other hand, it is attended with several insuperable Objections, we cannot but be confirm'd in the Opinion, which any one would be apt to form upon the first view of it, that it is nothing more than an Ingenious Contrivance to amuse us, and a pretty Application of the Experiments, made upon thin Plates of Glass, Water and Air, to Natural Bodies, if it could have been prov'd that those Bodies consisted of such transparent Plates, and that if they did, such a Contexture or Assemblage of Plates was sufficient for the Solution of the Phenomenons design'd, which is not done.

§. 39. But as the Case stands, whatever we have said against the Corpuscular Philosophy in general, and to prove the Unreasonableness of considering Bodies as made up and constituted of little Corpuscles, will be alike valid against what is here suppos'd, as also what in particular we have alledg'd in Contradiction to the 1<sup>st</sup>, 2<sup>d</sup>, 3<sup>d</sup> and 4<sup>th</sup> Propositions, so far as they relate to the present Theory of Colours; nothing of which we shall now repeat, we only intend to consider farther, what is more peculiarly advanc'd in the 5<sup>th</sup>.

§. 40. The first thing is, that the Parts of all Natural Bodies are in the Form of thin Laminæ or Plates, which is not evidenc'd by any of the preceding Propositions; for tho' we should grant them to be transparent, and interspers'd with Vacuities of a different Denseness, their Figures yet would be undetermin'd; that particular Structure of Bodies is therefore introduc'd into the present Proposition, upon the Account only of several \* Observations made by this Philosophy, upon thin Plates of Air press'd betwixt two Prisms, and on Bubbles blown from Water and Soap, which according to their different Thicknesses, and the Obliquity of the Rays which fall upon them, produce various Colours, transmitting one kind of them to the Observer, and reflecting another; the Proof therefore of the preceding Proposition is from the Affinity of the Properties, which is experienc'd betwixt these Plates of Air or Water, and the Parts of Natural Bodies.

*This Solution confuted, from the Corpuscular Philosophy, and Prop. 1<sup>st</sup>, 2<sup>d</sup>, 3<sup>d</sup>, and 4<sup>th</sup> not being true.*

*If it were not, its Proof yet depends upon an Analogy betwixt the Parts of Bodies and the thin Plates of Air or Water, which Analogy is not certain.*

\* Sir Is. Newt. Opticks Par. 1. & 2. Book 2.

§. 41. One Instance, produc'd to shew the Analogy betwixt them, is that of the Feathers of Birds, the Webs of Spiders, and the colour'd Fibres of Silks appearing of various Colours, by changing the Position of them to the Eye, and this is suitable to what thin Plates of Air and Water have been observ'd to do; but if this is a Proof that the Colours of Silks, the Webs of Spiders, and the Feathers

*That the Feathers of Birds, or Webs of Spiders, or the Fibres of silk, do not prove the Analogy.*



Feathers of certain Birds, which change their Colour by their different Position, are form'd of small transparent Laminæ or Plates of Glass, Air, or Water, because they likewise change their Colour by their different Position, it will, on the contrary, follow, 1<sup>st</sup>, that Plates of Glass, or Air, or Water, are made up of little Feathers, Webs, or Fibres of Silk, as well as these of the other: 2<sup>d</sup>, That since the Colours of most Natural Bodies are not chang'd by their different Situation, therefore the Colours, of most Natural Bodies, and the parts of them, have not the same Properties as those of the thin Laminæ of Air, or Water, to w<sup>ch</sup> they are suppos'd correspondent.

*The Colours of Silks, Cloths &c. growing more faint by being immers'd in Water or Oyl, no Argument of this Analogy.*

§. 42. Another Example brought of their Agreement is, that the Colours of Silks, Cloths and other Substances, which Water or Oyl can intimately penetrate, become more faint and obscure, by being immers'd in those Liquours, and recover their Vigour again, by being dry'd, and the same happens in the thin Plates of Air and Glass: If this Reasoning was just, we may 1<sup>st</sup> affirm, that all Bodies which receive the same Die (as Oyl or Water are a sort of one here) have the same kind of parts, and therefore the parts of Bodies may be reduc'd to those of Wool, as well as by this Argument to those of Glass, since in the same Die other Bodies will admit of the same Tincture which Wool do's; 2<sup>d</sup>, It is strange that whereas, according to §. 32. the Repletion of the Pores of Bodies cause Transparency, it should in the present produce Obscurity and Opakeness.

*Leaf-gold, the Infusion of Lignum Nephriticum, transmitting one Colour, and reflecting another, no Argument of this Agreement.*

§. 43. A Third Agreement betwixt them is, that Leaf-gold, some sorts of painted Glass, the Infusion of Lignum Nephriticum, and some other Substances reflect one Colour, and transmit another, correspondent to what is observ'd of these thin Plates of Air or Water; but, since this is not a general Affection of all colour'd Bodies, and only belongs to some, it will admit of the same Answer, as in §. 41. seeing other Fluids, and the most of them, may reflect and transmit

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mit nearly the same Colour or Appearance, as Water, or Wine, and several Tinctures in Chymistry; and hard Bodies (as Silver in particular) do not transmit any other Rays, than what they reflect.

To enter nearer into this Question, there are no Bodies which transmit a peculiar sort of Rays, and reflect a different, unchangeably, which this Philosophy seems to imagine, upon this Supposition that the Rays are Heterogeneous in Light, and Matter is Homogeneous in Bodies, and only diversify'd by its Figures and its Pores; from whence it comes to pass that, the Pores of the same Body being Similar, there is only one kind of Rays transmitted thro' them; and as the Parts of the same Body are alike Similar too, there is only one kind of Rays reflected, and since the Pores and the Parts in differing Bodies vary likewise, they will transmit and reflect, each its distinct Rays, which shall be different from the former.

On the contrary, the Heterogeneous Rays in Light are evidenc'd to be false, and Homogeneous Matter is not at least prov'd to be true; and yet if both were infallibly certain, there could be no Account given, why either one sort of colour'd Rays should be reflected from one kind of Figure, as a Triangular or a Globular, or why one sort of colour'd Rays should be transmitted thro' one kind of Pore in preference to another, or lastly, as we shall afterwards observe, why, or in what manner, all the other Heterogeneous Rays in Light should be extinguish'd, excepting one kind, which is reflected, and another which is transmitted.

Moreover, it is plain in Fact and Experience, that if we take any liquid Substance, as *Tinctura Minfycti*, which is of an Orange Colour, if the Rays of Light are transmitted thro' it, of a dusky Green, if a white Paper is held behind it, if any dull and opake Body, of a Dark-brown, and so it is generally, and perhaps in all Fluids, that they become of that Colour to the Eye, which is

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compounded of their own, and that which is transmitted thro' them, whether from the Rays of the *Sun*, or from Red, Blue, Purple, or any other Colour, which belongs to Natural Bodies, held behind the Transparent Fluid; so little Foundation is there for such an Affirmation, that Transparent Fluids always transmit one Colour, and reflect another, whereas a Transparent Fluid, by various Colours, as of *Æther*, the *Sun's* Rays, or the Colours of Natural Bodies mixing with its own, may occasion several distinct Appearances, and if so, will be a Proof, that no Colours are refracted from Transparent Fluids, but transmitted with a Tincture of that, thro' which their Transmission is made; and the same may be said in Solid Bodies, as Leaf of Gold, where the Thinness of it is such, as to be capable of transmitting the Rays of Light, or even those of other Bodies.

From hence also an Account may be given of *Dr. Hook's* Experiment, without the present Doctrine of Fluids transmitting only one sort of Rays, and reflecting those of another; the Experiment is, that if two Fluids, the one Blue, and the other Red, are set together, they will become Opake, altho' separately they were Transparent; w<sup>ch</sup> may be easily conceiv'd upon the foregoing Hypothesis, that Liquors assume those Properties (in relation to Colours) which arise from the Mixture of them, without any such imaginary Transmissions and Reflections of Rays, which are suppos'd: For moreover, it is not unreasonable to think that Blue, which has the least Action, and Red, which has the greatest, should produce none, that is, no intermediate Degree betwixt them of Orange, Yellow, or Green, but they cannot produce Whiteness, which is compounded of all the various kinds of Colours of Light, and therefore we may probably conclude they will, a Darkness, or Opacity.

Farther, if we fill two small Glasses, with flat polish'd Bottoms, the one with Aqua-fortis, deeply dy'd  
Blue,



Blue, the other with Oyl of Turpentine dy'd Red, and afterwards place the one upon the other, we can discern several Bodies thro' them; whereas, according to this Theory, no Object should appear thro' both the Transparent Fluids, because if one transmits only Red, the other only Blue, no Rays can pass thro' both; this is certainly unaccountable in the present Doctrine of Light and Colours, which yet is explicable enough, upon the Hypothesis we have mention'd; for in *Tinctura Minjsyhti*, tho' a white Paper held behind it, makes it appear of a Duskyish-green, which is Orange in it self, yet we may easily discern the Whiteness of the Paper thro' it, and a confusion of Letters, if any are writ upon it; because tho' the Mixture of Rays should alter the Colour to a Dark one, it is not from thence necessary that it should not be transparent, since in Red, Yellow, Green and Violet a Transparency is preserv'd, where the Colours are acknowledg'd to be of a different Complexion, notwithstanding, according to the present Theory, a perfect Opacity should ensue.

§. 44. A 4th Analogy is, that colour'd Powders, which Painters use, may have their Colours a little chang'd, by being very elaborately and finely ground, agreeable to which the Colour of a thin Plate is chang'd by varying its Thickness; if this also were a true and an exact Comparison, betwixt the Properties of each, it would only amount to this, that the Colours, which Painters use, may be reduc'd to those of transparent Plates, but not the Colours of Natural Bodies, which are not chang'd by any Diminution, for Gold, tho' extended upon Wire to an infinite Thinness, preserves its Complexion, without the least Variation; that, moreover, which makes this Analogy the less convincing, is, that it is very hard to conceive, or at least to prove, how in the powdering of the Colours, which Painters use, the Parts should be rather flatten'd

Philosoph.  
Transact.  
Abridg'd, Vol.  
1. P. 168.

*The colour'd  
Powders us'd by  
Painters, and  
changing their  
Appearance by  
being ground,  
no Proof of this  
Analogy.*

into thinner Plates, then broken into lesser Plates of the same Thickness; since, in the beginning of this Proposition, and its Demonstration, the very Reason that is assign'd for the parts of Bodies being of the same Colour with the whole Mass, is, because it is rational to think, that the whole is divided into Plates of the same thickness; either therefore there can be no Account given, why the parts of Natural Bodies are of the same Colour with the whole, or else there can be no Account given, why the parts of colour'd Powders should not be.

*The Precipitations or Coagulations, experienc'd in Chymistry, do not justify this Analogy.*

§. 45. A 5th Analogy is still less to the purpose, that by mixing diverse Liquors in Chymistry, very odd and remarkable Productions and Changes of Colours may be effected, of which no Cause, as is suppos'd, can be more obvious and rational, than that the Saline Corpuscles of one Liquor do variously act upon, or unite with the tinging Corpuscles of another, so as to make them swell or shrink, whereby not only their Bulk, but their Density also may be chang'd, or so as to divide them into smaller Corpuscles, whereby a colour'd Fluid may become transparent, or so as to associate several of them into one Cluster, whereby two transparent Fluids may compose a colour'd one; in which Account, this Philosophy do's so evidently joyn it self to the Corpuscular, the Absurdities of which are, I hope, sufficiently apparent, that it seems wholly unnecessary to give a particular Consutation of it; all that we shall say, is, that these Saline Corpuscles are capable of performing Wonders, when they can make Bodies swell or shrink, or cut them into pieces, or drive them together in heaps, just as they have a Mind to it, and as the Humor takes them: For if we own the Effects to be produc'd, this Philosophy which acknowledges an Inertia, and a bare Passiveness in Matter, can never assign the Causes which produce them, unless by attributing a kind of Arbitrary

bitrary Action to Matter it self, deriv'd from the Will of the Philosopher.

§. 46. However, supposing the Bulk or Density was chang'd, by this unknown Action of the Saline Particles, and that they could divide or collect the Parts of Bodies at pleasure; this is a very remote Demonstration of these Parts being form'd into Plates, answerable to those of Water or Air, to which they are to bear a Resemblance; and indeed there seems to be no greater a Confession of the Weakness of this Doctrine, than its having recourse to such Explications; for these Saline Corpuscles, as they change the Density of the Parts, they may at the same time also fill the Interstices of those Parts, and if so, according to this Philosophy, the whole will be so far from being Colour'd or Opaque, that it will be transparent: These Saline Particles likewise may divide the Parts into smaller Corpuscles, by which means, if they are of a definite Bigness, they may become Opaque, instead of Transparent. Lastly, if these Saline Corpuscles should gather the Parts of Bodies into one Cluster, instead of being Colour'd, the Congeries of 'em might be Transparent; for if a thin'd or a plated Body should be broken into fragments, according to this Philosophy, there is no Reason why a heap of these fragments should not be of the same Colour, and consequently of the same Transparency, if the Parts are so.

§. 47. Lastly, it is said, in the Atmosphere, when Vapours are first rais'd, they do not hinder the Transparency of the Air's being divided into Parts, too small to cause any Reflection in their Surfaces, but when, in order to compose Drops of Rain, they begin to coalesce and constitute Globes of all intermediate Sizes, Clouds are form'd of Various Colours, according to the different bigness of the Globes which make them, and it cannot be conceiv'd, how so transparent a Substance as Water, should be sufficient for the Production of these

*The Doctrine of Saline Corpuscles, causing the foremention'd Precipitations and Coagulations, examin'd.*

Sir Is. Newt. Opticks Prop. 3. Part. 3. Book 2. Prop. 4. Part 3. Book 2. Prop. 5. Part 3. Book 2.

*The Division of the Parts of Water in the Atmosphere consider'd.*

Sir Is. Newt. Prop. 5. Par. 3. Book 2.



Colours, unless they proceed from the various Sizes of the Fluid, and the Globular parcels of it: In this part of the Analogy it is taken for granted, that the Parts of Water are the finest and most subtle, when they are first rais'd, whereas it is reasonable to think, they are the grossest; since the same Heat which rais'd 'em from the grosser parts of the Earth or Sea, by acting farther on them, would still in all probability refine and divide them; it is likewise taken for granted, that after these Vapours are rais'd, they coalesce, without giving so much as any plausible Reason why they should, since the same Heat which raises ought to dispel them; if yet they do coalesce, it is also taken for granted, that they are of a convenient Size, to reflect or transmit Colour, of which there ought, at least, some Proof to have been alledg'd; and as to what respects the Substance of Water, tho' it is imagin'd to consist of Globular, or Smooth and Oblong parts, by the Corpuscular System; in the first place, this Philosophy, in the very Proposition we are now considering, do's presume that these Parts are not Globular, but have the Resemblance of transparent Plates; and in the next, it is not certain, but an Hypothesis only, that Clouds and Vapours are form'd of nothing else but Water, since there may be several other Substances rais'd by the Activity of the *Sun's* Rays, as well as Water, and which mixing and joyning with it, may be the Cause of these several Appearances.

*If this Analogy was just in some respects, it would not be sufficient to solve the Colours of those Bodies to which the thin Plates of Air or Water, are not analogous.*

§. 48. After this tedious Pursuit of the Principles of the present Doctrine, thro' its several Mazes, let us now recollect our selves, and inquire, Whether, if all these Comparisons betwixt the Plates of Air or Water, and the Parts of Bodies were accurate and true, it would be a Reason for us to receive the Doctrine affirm'd by them; and it is certain they would not, because they are particular, and do not reach the Cases of all Bodies

in general, which they ought to do; for if, to explain different Phenomenons, different Arguments are produc'd, it is the same as proposing for every Difficulty a new Hypothesis; and it is not enough to say, that the Properties of Natural Bodies, or the Parts of 'em agree with those of the Plates of Water or Air, in one respect, or another; for unless they do in all, what is an Argument in one Case, will be an Objection in a Second.

§. 49. If yet the Properties of thin Plates of Air, or Glass, or Water did absolutely agree with the Parts of Natural Bodies, which they do not, since there may be the same Effect produc'd from different Causes, tho' the Parts of Natural Bodies should be answerable, in their Appearances, to those which we find and experience from the Plates of Air, or Water, or Glass, it would not follow, that the Parts of Natural Bodies should consist either of Air, or Water, or Glass, or Air and Water, or Glass, of the parts of Gold, or an Adamant, which they must necessarily do, if the same Effects do always arise from the same Causes; that is, Air and Water, or Glass, would be transform'd into Adamant and Gold, or these into the other; for if, because two Substances, as the thin Plates of Air and Water, or Glass, and the Parts of Natural Bodies agree in a third Property as Colours, and the Variations of them, the Parts of the latter are therefore entitled to a certain Transparency observable in the former, for the same Reason they may lay claim to all the other Qualities we find in them; and on the contrary, Air and Water, or Glass, may likewise challenge the Solidity of Gold, and the Hardness of an Adamant, by the Force and Conviction of such an Analogy; since besides, what can be more Reasonable, than that the Parts of Natural Bodies should rather consist of that Transparent Substance, to which they are made analogous, than of any other Transparent Substance, betwixt which and them, there is no Affinity prov'd?

*If this Analogy was true and exact, it ought to take in other Qualities of Bodies which it omits, because not necessary to the present Hypothesis.*

This Reasoning obtains upon the Supposition, that the same Effects cannot be produc'd from different Causes; if they can, then if Colours, and the several Properties of them, arise from thin Plates of Glass, or Air, or Water, and the same are produc'd from the parts of Natural Bodies, it will not be certain that the parts of Natural Bodies consist of thin transparent Plates, since the Causes of these Colours and Properties in the one, may be very different from the Causes of them in the other; and as Heat may be excited by the Fire, or Attrition, or by the Mixture of an Acid and an Alkali, so it is not evident but the same may obtain in Colour, and the Method and Contrivance of Nature may be as different in producing Colours from the thin Plates of Glass or Air, from that which it uses in the Production of 'em from the Parts of Natural Bodies, as the abovemention'd ones of Heat, without either supposing that Fire is Attrition, or Attrition is an Acid and an Alkali, or as in the present Case, that the Parts of Natural Bodies are Plates, or like Plates of Air, Glass or Water.

*If this Analogy was not Chimerical, it ought to furnish us with the truest Solution of the other Properties of Body, as well as Colour.*

§. 50. It is also to be observ'd, that in a True and Rational Philosophy, we are not only to consider how those particular Phænomenons may be solv'd, which we professedly examine into, but likewise how such a Solution is correspondent to other Appearances in Nature; let us therefore presume the present Hypothesis of Bodies consisting of small transparent Plates or Laminæ to be the best that could be devis'd, or offer'd, for a Complete and Perfect Account of Colours, if such a Contexture of Parts is not equally apposite to all other Explications of the Properties of the same colour'd Bodies, the Hypothesis, however exact in one respect, in twenty others will be short and defective; thus, if we should grant these Transparent Laminæ of different Thicknesses to the Theory of Colours, when the same Corpuscular Philosophy comes to explain

Hardness



Hardness or Softness, or Fluidity, and gives us a Reason of the Coagulums, Dissolutions, and Precipitations in Chymistry, of Heat and Cold, of the Rarefaction and Condensation of Bodies, of the several Smells and Tastes which belong to them, we shall immediately find these necessary thin Plates to have chang'd their Shapes, and sometimes to resemble little Wedges, at others, little Globes, now they are of an Oblong Form, and presently after they are become into Hooks, then they shift into Cones or small Wedges, and in a trice contract themselves into Needles, and when they have run thro' the various Forms that can be imagin'd, they at last dwindle into a Subtile Matter, which will put on any Figure, Size or Dimension, which shall be assign'd it; it is certainly impossible to reconcile all these different Shapes with the Transparent Laminæ, if they are the Ultimate parts of Natural Bodies, and like the Laminæ from which their Analogy is drawn; if they are not the Ultimate parts of Bodies, then they may be of a different Colour from the Whole, contrary to this Hypothesis; because by dividing them in their Parts, there will be Interstices of a different Medium betwixt them, and because by dividing them in their Crassitude or Grossness, they may be diminish'd in their Density and Thickness; and if they are not like the Plates from whence the Analogy is made, there is no Reason for the Comparison it self. If yet these Laminæ could be chang'd into a hundred Shapes, and continue *Themselves*, neither they, nor any other Form, or Shape of them, could give an Account how they cohere, which Cohesion is, notwithstanding, as necessary a Phenomenon to be solv'd, as Opacity or Colours.

§. 51. We have hitherto inquir'd into the Causes of the Colours of the Parts of Natural Bodies, which if allow'd, they could not determine for us, why the whole should be of the same Colour; for supposing any colour'd Body, as Gold, to consist

Sir Iſ. Newt.  
Opticks Prop.  
1. 5. Par. 3.  
Book 2.

*If Bodies consist of small Lamina or Plates, the Colour of the whole would be*

*different from  
that of its  
Parts.*

Sir Iſ. Newt.

Opticks Prop.

5. Par. 3. B. 2.

fiſt of an infinite number of ſmall Laminæ or Plates, whoſe Thickneſs is ſuch as to reflect a Yellow; the Ultimate parts therefore of ſuch a Body will be of a Yellow Appearance, and conſequently, if theſe thin Plates are not joyn'd together by any point of Contact, Gold will not be a hard and reſiſting Subſtance, if they are, where they are united, the two ſmall Laminæ being cemented together, will either conſtitute a Lamina of a different Thickneſs, and, for that Reaſon, of a different Colour, or they will at leaſt form two Laminas ſo near to each other, that the Interſtice betwixt them will cauſe no Alteration in the Refraction or Reflection of them, according to Prop. 4<sup>th</sup> of this Philoſophy, that is, it will be the ſame in Effect, as if they were united; and therefore in either Caſes the two Laminæ will produce a diſtinct Colour from Yellow, and Gold conſequently will not in the whole, or in ſeveral of its Parts, unleſs in the Ultimate ones, be of that Colour.

*The Colours  
produc'd from  
thin Plates, not  
the ſame with  
thoſe which are  
imprefſ'd upon  
us from Natu-  
ral Bodies.*

§. 52. But that which is farther to be noted in this Philoſophy, is, that it takes for granted, that the Colours produc'd by the thin Plates of Air or Water, and thoſe from Natural Bodies are the ſame; for if they are not, the Analogy betwixt the one and the other entirely falls, whereas there's nothing more demonſtrable, than that the Red and Blue, or Violet, or Green, which is produc'd from the Refraction of theſe Plates, as much differs from thoſe Colours, when reflected from Natural Bodies, as the Red of a Roſe, from that of a Ruby, or the Green of a Leek, from that of ordinary Glaſs, or the *Sun's* Colour in the Rainbow; and here we cannot but lament the Scarcity of Words in Languages in general, and the Unaccurateness of our Reasonings thereupon, which often ranges under the ſame Terms very different Ideas, and argues upon them, as if they were really and individually the ſame, when yet by what we call Red, or Blue.

OR

or Green, there may be as many distinct Perceptions rais'd in our Minds, as there are by White or Black.

§. 53. What is still more remarkable in the present Doctrine, is, that the Difference of Thickness or Density in the Plates cannot possibly produce a Difference of Colours, even according to the Notions of this Philosophy; since it considers nothing else but an Homogeneous transparent Substance, contriv'd into Plates of a various Depth and Crassitude, which by Prop. 1<sup>st</sup> and 4<sup>th</sup> cannot produce different Colours; for by Prop. 1<sup>st</sup> in the confines of equally refracting Mediums, there is no Reflection, and by Prop. 4<sup>th</sup>, the Parts of Bodies and their Interstices must not be less than of some definite Bigness to render them Opake and Colour'd; if therefore there are transparent Plates of different Thicknesses, and no different Mediums intercede them, whether the Plates are thicker or otherwise, there will be no different Reflection.

*The different Thicknesses of Plates, according to this Philosophy, cannot produce different Colours.*

§. 54. Lastly, altho' this was allow'd, that the Density or Thickness of the Plates was the occasion of Colours in Natural Bodies, and that Bodies were form'd and constituted of such Plates, this Hypothesis, which with so many Arguments is contended for, would by so many Arguments confute the other of Heterogeneous Lights in the Rays of the Sun; for if the Colours of Natural Bodies are owing to the Difform Rays of the Solar Light, as is pretended in one Hypothesis, how is it possible, that the same Colours of Natural Bodies should proceed from the different Density or Thickness of the Plates, of which those Natural Bodies are compos'd, according to the other Hypothesis; either the Sun's Rays must be alter'd and chang'd by the Thickness of the Plates, or not; if they are, then there will be no occasion to advance an Heterogeneous Light for the Solution of

*The Hypothesis of Bodies consisting of different Plates contradicts the former of their Colours arising from Heterogeneous Rays of the Sun.*



Colours, since the different Thicknesses of the Plates, on which the Light impinges, may make an Heterogeneous Light of an Homogeneous, if the *Sun's* Rays are not alter'd by the different Thicknesses of the Plates, it will still lie upon the present Philosophy to prove, how some Bodies reflect one sort of colour'd Rays, and other Bodies another kind of colour'd Rays; and consequently we are left in the same perplexity, in respect of the Colours of Natural Bodies, as before the Contrivance of these different Laminæ.

*The remaining Propositions in this Philosophy, not necessary to be consider'd, since they depend on the foregoing.*

§. 55. And after this particular Examination into the Grounds of this Hypothesis, it will be unnecessary to proceed to the 6<sup>th</sup> and 7<sup>th</sup> Propositions, which we shall only name; the 6<sup>th</sup> is, that the parts of Bodies, on which their Colours depend, are denser than the Medium, which pervades their Interstices; the 7<sup>th</sup>, that the Bigness of the Component parts of Natural Bodies may be conjectur'd by their Colours, both which depend upon the same Analogy of the Plates of Air and Water, to the parts of Natural Bodies, and therefore do not want any farther Comment upon them.

*The Supposition of Vacuities reflecting Light, a Proof of the Absurdity of this Philosophy.*  
Sir II. Newt.  
Opticks Prop.  
8. Par. 3. B. 2.

§. 56. To confirm the Unreasonableness of this Corpuscular Account still farther, we shall mention one Absurdity from it, which yet to make it pass for none, is form'd into a Proposition, That the Cause of Reflection is not the Impinging of Light, on the Solid or Impervious parts of Bodies, as is commonly believ'd, for which there are Seven Reasons given, and all of them terminate in this, That if the Corpuscular Philosophy is true, and there is nothing more to be consider'd in Bodies than their Parts and their Pores, it will be impossible to assign a Reason in the first place, why Air should have as strong, or a stronger Reflection of Light, than Glass or Water has? since, according to the Corpuscular System, Air must have fewer Parts, and more Pores than Glass or Water; or, in  
the

the second place, Why Glass should transmit, in any Degree of Obliquity of the Rays falling, more of such incident Rays, than Air do's, and reflect fewer; or, in the third, Why at the same Obliquity of Incidence in a second Prism, which has its Lights refracted to it from the first, the Blue should wholly impinge on those parts so as to be all reflected, and yet the Red find Pores enough to be in a great measure transmitted; in the fourth, Why the Rays should not impinge on the parts of Glass, as much when they are contiguous to other Glass, as when contiguous to Air, and yet when two Glasses touch each other, there is no sensible Reflection, &c. All which Observations are so many Objections against the Corpuscular Philosophy, rather than a Confirmation of the present Proposition; since, if we acknowledge there is nothing more in Bodies than Small Similar Parts of Matter, and Spaces which intervene them, it will be impossible to give an Account of these Phænomenons, unless by saying, that Light may be as well reflected from the Interstices of Bodies, as the Solid parts of them; but as we deny the Corpuscular Philosophy to be true, and affirm that the Nature and Constitution of Bodies do's not depend upon their Parts, or the Vacuities, which are interspers'd betwixt them, so we are also acquitted of so manifest an Absurdity, which in all the Parts of it is a Contradiction even to this Philosophy; seeing it is impossible that Bodies should reflect the Rays incident upon them, from their intermediate Spaces, both because vacuities in their own Nature have no resistance, and because if they had, they could not do it, unless they produc'd a different Colour, which they are not suppos'd to do; for the intermediate Spaces, in such a Case, may be as justly conceiv'd to resemble Transparent Plates of a different Thinness, as the Parts of Natural Bodies; If a Uniform Force is diffus'd thro' the several Vacuities from the Parts

of Natural Bodies, 1<sup>st</sup> Reflection will depend as well upon the Impervious parts as the Pervious, that is on both alike, contrary to the Proposition; 2<sup>d</sup>, there will be no Cause assign'd for the different Reflections of Glafs and Air, since the Force will be uniformly spread from their Parts, and equally capable of reflecting the Incident Light.

*Bodies transmitting the Rays of one Colour, and reflecting those of another, no Argument for Heterogeneous Rays in the Light of the Sun.*

§. 51. There is one Argument farther, which is more particularly made use of in Vindication of this Philosophy, namely, that the Parts of Natural Bodies, as well as the Plates of Air, or Water, transmit one kind of Colour, and reflect the Rays of another, to which it was before in general answer'd, that this Reflection and Transmission was not a Property which belong'd to the Parts of all Natural Bodies; that if it was, the same Effect or Appearance in Nature might proceed from different Causes, &c. We shall here add, since we could not before take Notice of it, That seeing the present Philosophy affirms Light to consist of a Mixture of several Differently-colour'd Rays, tho' we should acknowledge the Parts of all Natural Bodies to transmit one Colour, and reflect another, yet we cannot see how this is consistent with a Light almost infinitely Heterogeneous, there being no Account given of the vast Number of Rays in Light, which are suppos'd to be neither reflected nor refracted; if they are, as it were, extinguish'd, and dye on the Surface of the resisting Medium, what Property is that in Bodies, which is so fatal to a hundred Colours of Light, and which can distinctly blot 'em out, and erase them from being, and yet is so indulgent to some others, as to cherish and receive every Ray that is incident on them? If it is said to be an occult Quality, that kind of Jargon has been long since exploded; or on the other hand, if they are not extinguish'd, but reflected at different Angles, so that one sort of Rays only reach our Sensation, whilst the rest are determin'd



to other Parts, it will be hard, and indeed impossible to explain without an occult Quality, why one sort of Rays only are reflected to the Eye, that is, why one sort in preference to another, have a direct Reflection, whilst the rest are Oblique; since Red or Blue, or Light it self, are seen at all Angles: Second, It will be as difficult to shew, if the colour'd Rays, which do not reach the Eye, cannot affect it in one Situation or Posture, why they should not do it in another, if they are reflected at all, unless these Reflections are suppos'd to be within the Parts of the Body it self, and if they are, why those Reflections should not, by the progress of the Rays, be the occasion of the Transmission of several kinds of them: Besides this, it is evident by several Experiments, that colour'd Fluids may reflect and transmit nearly the same Rays in certain Circumstances; Lastly, Whether these Rays, which do not appear, are reflected, or extinguish'd, it will be inconceivable, how Light and Colours should be the same, in the fulness and plenitude of their Appearances, when in the one Case, there is an Assemblage of all the Rays, and in the other a Subduction of all but one; and we may as well affirm, that 9 and 10, are equal to 9 taken out of 10, as that all the Parts of a Body should be equally illuminated by Light, or Red; when in the first Instance there are 10 or 20 Rays, or whatever the Number of colour'd Rays are, for 1 in the Second. The Cause therefore of Bodies in general, or thin Plates of Air, or Glass, or Water, sometimes reflecting only one Colour, and transmitting another, we shall endeavour to assign in the Principles we intend to advance; which if we can do, (as we have already, in some measure, done §. 43,) without the Assistance of a Corpuscular System, we hope it will not be ungrateful to all Sincere and Impartial Inquirers into the Forces of Nature.

## CHAP. V.

## Concerning the Modern Doctrine of the Prism apply'd to the Solution of the Phenomenons of it.

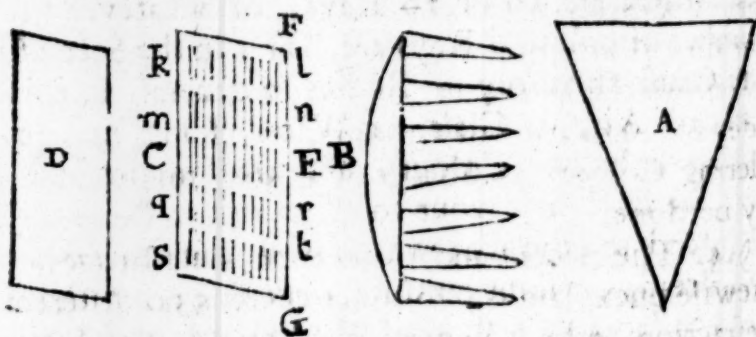
*The Phenomenons of the Prism, next to be consider'd.*

§. 1. **A**FTER tracing this New Theory of Colours, thro' its several Labyrinths and Meanders we shall finish our Inquiries concerning it, with an Examination into the Phenomenons of the Prism, and the Rain-bow, and the Solutions it gives of them.

*The Images made by Colours refracted from the Prism, and trajected thro' the Interstices of a Comb explain'd.*

Sir Is Newt.  
Opticks Prop.  
8. Par. 2, B. 1.  
Fig. 12.

§. 2. It is observable therefore, that if Light is refracted thro' a Prism, and a Comb held behind it, with a Paper plac'd beyond parallel to both, to receive the Rays projected from the Prism, thro' the Interstices of the Teeth of the Comb, that there will be painted upon the Paper as many Images, with the several Orders of prismatick Colours, as there are Intervals betwixt the Teeth, that if the Comb is mov'd slowly upwards and downwards, these colour'd Images will suitably rise or descend upon the Paper; and if one of them is intercepted, the rest will diffuse themselves into its room; that if on the contrary, the reciprocal Motion is quick,



or the Paper farther remov'd from the Comb, the Colours vanish; and lastly, that in this remote Position of the Paper, if one Side of it is

more

more inclin'd, so as to receive the most refrangible Rays, a Blue and Violet succeeds, if the other by which the least refrangible Rays are cast upon it, a Yellow and Red, all which is express'd in the present Schemes. *A* is the Prism, *B* the Comb, *C* the Paper, with the several colour'd Images drawn upon it, and *D* the same Paper remov'd at a greater Distance from the Comb, where it appears perfectly white.

§. 3. As to the Appearance of the Multiplicity of Images, observable in this Experiment, there is not the least Account given of it from this Philosophy; for since Light is suppos'd to consist originally of Heterogeneous Rays, which are only separated, and not produc'd by Refraction, what would be consequent upon the Interposition of the Comb, would be a Break or Interruption of the several Colours, as the Teeth of the Comb intercepted them, without any other Effect caus'd from it.

Farther, if one of these Images is intercepted, the rest will extend themselves into the vacant Interval, but if the Rays which are refracted are the same in Number and Quality, before, and after their Refraction, it will be impossible to explain how the same Individual Rays should take up a greater, or a less Space, without leaving some sensible Vacuities betwixt them, which are not colour'd or illuminated by them; or how they should strike into the Interstices of the Comb, in the same order and regularity of Colours, which yet, by considering Colours as Shades of Light, might possibly be done.

§. 4. The Ascent and Descent of these Images, is likewise unexplain'd; for since there is no different Refraction, which continues unalter'd, the Interposition of the Comb, as before, and moving it from *G* towards *F*, or the contrary, would only hinder the upper or lower parts of the Images from being

*The Multiplicity of Images in the preceding Phenomenon, not accounted for.*

*The Ascent and Descent of the Images, not solv'd.*



being impress'd on the opposite Paper, according to its approach towards *F*, or its recess from it, without such an Ascent and Descent, which is here suppos'd.

*The Distance of the Images from the Prism unsolv'd.*

§. 5. We may also add, that the colour'd Images are made by the Intervention of the Comb, at a much nearer Distance from the refracting Prism, than they are said to be in that Experiment, on which the whole Doctrine was first founded and contriv'd; for in that the Distance of 18 foot was requir'd, and in this less than one; since at *D*, which is about the Distance of a foot from it, they all vanish and disappear.

*The Confusion of the Images is said to produce a white Appearance.*

§. 6. Thus far we have consider'd the Colours projected on the opposite Paper, on the other hand, if the Motion of the Comb is quick, or if the Paper is remov'd to about the Distance of a Foot, the Colours are lost, and the Paper is chang'd into a White; the reason of which is said to be, because in both Cases the colour'd Rays are intermix'd with each other, and thereby produce Light, out of which they were originally separated and refracted.

*A Confusion of the Images not evident, from the quick Reciprocation of the Comb.*

§. 7. As to the quick reciprocation of the Comb, a Confusion of the colour'd Rays into one uniform Appearance, do's not seem evidently to result from it; for if the Colours pass'd thro' the Intermediate Spaces of the Comb, they would still preserve their distinct Images, and only be found to move faster up and down upon the Paper; thus if we turn a Prism round backward and forward upon its Axis, the Image changes its place, but do's not return so quick upon it self, as to make the least Confusion of the Colours that are projected, and what is experienc'd in one Image will be true of more, which are distinguish'd by certain vacant Distances. Moreover, supposing these Images incroach'd upon each other, it will be yet hard to conceive how they should do it in that exact Proportion,

portion, which is necessary to constitute white; for if there is any Inequality in the Mixture, if the more and less refrangible Rays are not punctually blended together, the Excess on the one hand, or the other, would be apparent; whereas this equal Confusion of colour'd Light is so far from being explain'd, that the contrary seems to be evident, namely, that granting the Images *kl, mn, CE, qr, st*, by a quick Motion fell in with each other in their Ascent, since the Colours are in a Parallel Order to *kl*, and the lowermost Order is Red, and the uppermost Purple, where the Refracting Angle of the Prism is turn'd downwards, the Purple of *mn* will mix successively with the Red, Orange, Yellow, Green, Blue, and Purple of *kl*, and so the Blue, Green, Yellow, Orange and Red of *mn* successively with the several Colours of *kl*, which likewise may be said of the other Orders, and therefore will not produce an equal Mixture, but a very unequal, as it is a successive one.

§. 8. There is another Case, in which the opposite Paper becomes white, namely, when it is remov'd at the Distance of a foot from the Prism, notwithstanding the Comb is still interpos'd betwixt them; but how, by the removal of the Paper, the Distinct Images in *CE* should mix in *D*, is undetermin'd, since Reason should rather oblige us to think, that the Images, by the Distance, would be enlarg'd, than that they were mix'd and contracted together.

*How the Images should mix, by the Paper being farther removed, unaccounted for.*

§. 9. Nor do's that which is alledg'd in the last place confirm this Doctrine, that if one side of the Paper is more inclin'd, so as to receive the more refrangible Rays, a Blue is observable upon it, and if the other, a Red; since it is a manifest Indication on the contrary, that the Colours are not mix'd, but preserve their Activity to such a certain Distance in the present Circumstance, beyond which they become languid, and are no farther apparent; for how Red and Blue should be mingl'd

*The Inclination of the Paper from one side to another, and from thence a Red or a Blue appearing, no Confirmation of this Doctrine.*

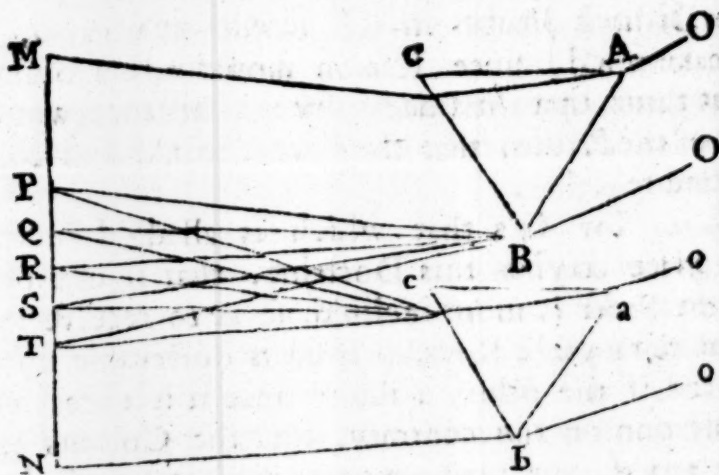
mingled with each other at the Distance of *D*, when, on the contrary, one lies on one Side of the Paper, by a little inclining of it, and the other on the opposite, this Philosophy should in Justice explain.

*These Experiments do not prove that Light consists of Heterogeneous Rays.*

§. 10. Notwithstanding our Dissatisfaction with the Reasons given for the several Parts of this Experiment, we do not deny but the Colours of Bodies mixt together, may produce a Colour-less Appearance, for which we shall endeavour to assign a Cause in our Principles; what we now contend for, is, that these Experiments do not prove that Light consists of Heterogeneous Rays, and, that they are to be accounted for rather upon another Theory of different Shades, produc'd from the same Homogeneous Light.

*No Relation betwixt the Experiments of the Comb, and the two Prisms.*  
Sir Is. Newt.  
Opt. Prop. 5.  
Exp. 13. Book 1. Par. 2.

§. 11. From the preceding we are carry'd to another Experiment, in which it is acknowledg'd, that the several Intervals of the Comb, in the former, perform the Office of so many Prisms in this, if so, we may be very reasonably allow'd to inquire, by what General Laws, in this Doctrine, the bare



Transmission of the Rays thro' the Interstices of a Comb, can be possibly exacted to the Refractions of them thro' as many Prisms; the Answer given



given in this Philosophy, is only that they have the same Effects, which do's not give any Explanation of the Causes of them.

12. The Experiment in Relation to Prisms, is, *The Experiment of the two Prisms explain'd.* that if two Prisms  $CBA$  and  $cba$ , are plac'd ei-  
ther in this Position, which is express'd by the Figure, or so, as that  $CB$  should be in a direct Line with  $cb$ , or in a Situation that is something different from a Parallel one, the Rays, which are refracted from the Interior Limits of the Prisms,  $B$  and  $ca$ , to  $PT$ , will produce a White, and if either of them is taken away  $PT$ , will be colour'd, which upon the return of the Prism to its former Position, will again appear White.

§. 13. As to the last part of this Experiment, *That the Prisms being plac'd together produce a White, and replac'd after displacing 'em, that they produce the same White, has no Argument or Conclusion in it.* which is made use of to ascertain the truth of the present Hypothesis beyond almost a Possibility of contradicting it, namely, that if two Prisms are plac'd together, a White ensues, but if one of the Prisms is taken away, the several Orders of Colours are rang'd on the Paper, and the Prism being restor'd to its first position, the Effect produc'd is white again; what Conviction have we of the real Composition of Light from such an Observation?

since, if these Prisms refract the Rays at first, so as to make a White, there is no doubt but they will do it again, or at any time, when, after the Separation of the Prisms, they obtain their former site and posture.

§. 14. The Question therefore is, Whether in the present Hypothesis of Light, proceeding from the equal Mixture of Differently-colour'd Rays, there is, or can be, such a Mixture by the Refraction of the Prisms: And, in the first place, we have Reason to object against any Rays proceeding, and being refracted in Colours from  $O$  or  $o$ , to  $C$  or  $c$ , that is, thro' the thickest part of the Prism, because by those Experiments we have been capable of making, there do's not appear to be any part of the

co-

colour'd Image owing to the Refractions, which are suppos'd at the bases of the Triangles  $CAB$  and  $cab$ .

*Inconceivable how the Rays should be refracted in that manner, which this Scheme supposes.*

§. 15. If this were allow'd, it is yet unaccountable how  $OB$  should be refracted at the Point  $B$ , so as the several Rays  $BP$ ,  $BQ$ , &c. should coincide with Rays, which are refracted from  $oa$ , thro' the Basis  $ac$ , namely,  $cP$ ,  $cQ$ , &c. or how  $OB$ , at  $B$  or  $oa$  at  $c$ , the first, by not entering into the Prism, and the last after its Transmission thro' it, should admit of different Refractions, namely, to  $P$ ,  $Q$ ,  $R$ ,  $S$ , and  $T$ ; for if this were not suppos'd, the Rays would be determin'd in another Course from what is here express'd.

*How Rays should fill or take up a greater Space than it is possible for them to possess, unexplained.*

§. 16. Nor is it evident that  $OB$ , or  $oa$ , are split into several Rays, so that from each of them shall result, as they are represented in this Experiment, unless it can be prov'd that the Rays  $P$ ,  $Q$ ,  $R$ ,  $S$ ,  $T$ , may take up more Space than when united in  $OB$ ,  $oa$ ; if not, all of them, when dis-joyn'd, will only illuminate so many small points in  $P$ ,  $Q$ ,  $R$ ,  $S$ ,  $T$ , which taken together, will be equal to no more than the point  $B$  or  $a$ , or the Breadth or Thickness of the Line  $OB$ ,  $oa$ ; from whence it would follow, that in  $PT$  there must be Interstices, at least as large as  $PQ$ ,  $QR$ , &c. which are not inlightned at all, since the same will hold in any other point of  $AB$ , and a Ray of Light incident upon it, and its Refraction to  $MN$ , which is prov'd of  $B$ , and its incident Ray  $OB$ , and the Refraction of it to  $PT$ .

*How the Rays, which coincide with others of the same Colour, should produce a mixture of all the Rays, impossible, and consequently a White, unprov'd.*

§. 17. Farther, according to the present Scheme, the most refrangible Ray  $BP$ , in the Superior Prism, will coincide with the most refrangible Ray  $cP$  in the Inferior, the next most refrangible in the Upper, with the next in the Lower, and the least refrangible Ray  $BT$ , with the least  $cT$  in the other Prism; from whence there would not be an equal Mixture of the Rays, but each Ray betwixt  $P$  and  $T$  would meet with one of its Colour, which, instead of White, would produce Colours either

more

more intense, or such as any Prism would form, without the Conjunction or Assistance of a Second.

§. 18. This Philosophy was aware of the fore-  
 mention'd Difficulty, and therefore wisely and ve-  
 ry prudently contriv'd such an Adjustment of the  
 Rays, as might produce that Uniform Mixture,  
 which is requir'd to solve the present Appearance;  
 in order to this it is suppos'd, that the most re-  
 frangible Rays of the Superior Prism extend  
 themselves from *P* to *M*, and those of the Lower,  
 from *P* to *N*, the next most refrangible Rays, from  
 the Upper Prism, are made to extend from *Q* to  
*M*, those of the Inferior, from *Q* to *N*, a 3<sup>d</sup>, 4<sup>th</sup> and  
 the Last Sort, which are the least refrangible, are  
 respectively presum'd to fill the Spaces *R M*, *S M*,  
*T M*, being refracted from the Upper Prism, and  
 the same kind of Rays refracted from the Lower,  
 to be continu'd from *R*, *S*, and *T*, to *N*; for, as  
 this Philosophy adds, *By that means there will be*  
*an equal Mixture of them all.*

§. 19. To which sort of Reasoning, the first An-  
 swer we shall make is, That it is a strange way of  
 solving a Phænomenon, or an Effect in Nature, by  
 an Hypothesis that is originally presum'd, which  
 Hypothesis is here a Uniform Mixture of the Rays  
 to produce Light, and then taking what Arbitrary  
 Method we please to constitute such a Mixture;  
 for if, by the Adjustment of the Rays afore-  
 mention'd, there could not have been a Uniform  
 Mixture of them obtain'd, another at least might  
 have been found out, and if by that Means an E-  
 qual Mixture of them had been prov'd, the Solu-  
 tion, it seems, would have been as good as the pre-  
 sent, that is, the Hypothesis is laid down, by which  
 we are to solve all Effects of this Nature, a Phæ-  
 nomenon is produc'd, and is to come under the So-  
 lution of the same Hypothesis, which that it may,  
 we are left to dispose the Refractions of the Rays  
 at pleasure, so as to reduce 'em to an equal Mixture.

*The Evasion made use of by this Philosophy, to surmount the preceding Difficulty.*

*An Arbitrary Disposition and Adjustment of the Rays, in order to produce a Confusion of them, no Argument of the truth of the Hypothesis which they are made to agree.*



*If this Arbitrary Adjustment of the Rays was allow'd, the Confusion of them would be in a much less Compass than what is assign'd.*

§. 20. If this is not the Case in truth and reality, §. 14, 15, 16, are still to be answer'd, and what we shall here also object; supposing therefore this Adjustment of the Rays of Light, it will follow, that a perfect Mixture of them will be only in one Individual Line  $MN$ ; for if it is farther remov'd from the Prisms, the Rays will diverge from each other, and if it approaches nearer to them, the Rays, on the contrary, will be converging, in both which Cases, the Intervals betwixt them will not have their Colours equally mixt; thus, if the Space, comprehended betwixt  $CMPB$ , is possess'd by the most refrangible Rays, and the Space  $CMQB$ , with the next refrangible ones, it is evident that  $CMPB$ , &c. will have an equal Mixture of all the Rays from the Upper Prism, but not of the Lower, for  $BPe$  will not; and consequently  $BQc$ ,  $BRc$ , &c. will all of them be unequally mix'd, in respect of the Rays of the Lower Prism; from whence it is necessary to conclude, that  $MN$ , unless it is in that Situation where the Rays meet, that is, in one certain Position, will appear colour'd, which is not affirm'd by this Experiment.

*The Extremities of the white Image would be painted with Red and Blue, if this Arrangement was just.*

§. 21. Farther, if  $cPNb$ , in the Lower Prism, is taken up by the most refrangible Rays, there ought to be the same Latitude to the most refrangible Rays in the Upper, which would therefore rise much above  $M$ , and since the utmost Term of the next most refrangible Rays will fall below that of the most refrangible, in some point or other above  $M$  Purple or Blue would be apparent; again, since the least refrangible Rays, in the Upper Prism, lie betwixt  $T$  and  $M$ , there will be a point beyond  $N$ , to which the least refrangible Rays, in the Lower, will reach, as far distant from  $T$ , as  $M$  is, and the next refrangible Rays falling nearer to  $N$ , there will be a Red produc'd; and the same Argument is valid concerning all the Intermediate Rays, so that if  $MN$  is prolong'd, it will be colour'd on both hands, tho'  $MN$  should be White.

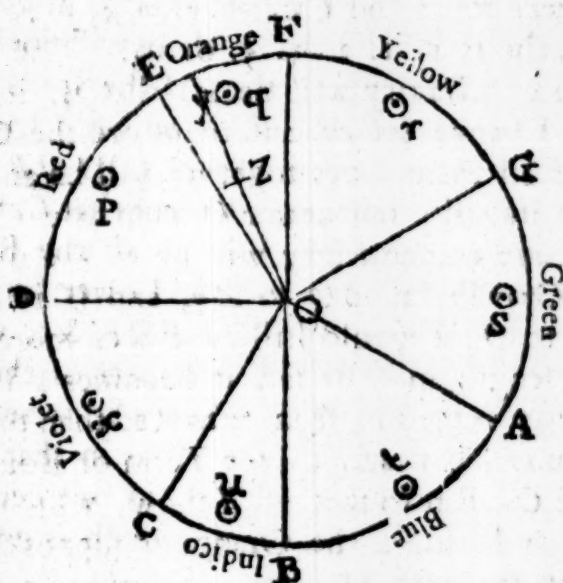
Besides,

Besides, it is inconceivable, how the Rays betwixt *CM, BP* and *cT, bN*, should, by Turns, represent the most and least refrangible Rays, and all the other sorts of them.

§. 22. As to the Rule given us for the Composition of Colours, namely, by dividing a Circle into several parts, proportional to the Seven Musical Tones, contain'd in an Eight; the first of

*The Rule for the Composition of Colours explain'd.*

Sir Iſ. Newt.  
Opticks, Prop.  
6. Par. 2. B. 1.



which Tones is represented by Red, and the several sorts of it, the next by Orange, and its several kinds, &c. however extraordinary the Contrivance of it may be, it is neither a Confirmation of this Doctrine, nor is it answerable to Nature; for, in this Rule, if any Number of Homogeneous Lights are propos'd to be mixt, and the Colour, which would result from such a Composition, is requir'd, it is determin'd in the following Manner: Let the Center of Gravity be found out, of those colour'd Arches, which are answerable to the Colours given to be compounded, and round each Center, let Circles be describ'd proportionable to the Number of the Ingredient Rays, find the Common Centre of Gravity of all these Circles, and draw a Line thro' it from the Centre *O* to the Circum-

ference; the Arch, in which the Common Centre of Gravity falls, will shew the Colour of the Mixture desir'd, and as it approaches nearer to the Circumference, or to the Centre *O*, the Intensity or Weakness of it; thus if 1 part of Violet is given, another of Indico, 2 parts of Blue, 3 of Green, 5 of Yellow, 6 of Orange, and 10 of Red, and it is inquir'd what Colour will arise from their Mixture, make the Circles *x, v, t, f, r, q, p*, respectively as 1. 1. 2. 3. 5. 6. 10. The common Centre of Gravity will be *Z*, that is, it will fall in the Orange Sector, and therefore the Composition of all these Rays together will be an Orange; it will likewise fall nearer *O* than the Circumference, and consequently will be to the utmost Intense Orange, as *ZO* to *Zy*, and if it had been nearer to *O*, it would still have been more diluted, till at length in *O* it self it becomes a White, it will lastly verge a little more to Red than to Yellow, because *Oy* is nearer to the Term or Boundary of Red *EO*, than to that of Yellow, which is *FO*; for from *E* to *F*, the Orange is suppos'd to have it's Intermediate Degrees, inclining continually from perfect Red to perfect Yellow; and the same may be said of the other Colours, namely, that Yellow verges continually from Orange to Green, and Green from Yellow to Blue, and so on.

*The foregoing Rule not answerable to Nature.*

Sir Is. Newt.  
Opticks Prop.  
6. Par. 2. B. 1.

§. 23. We, in the former Section affirm'd, that the Rule beforemention'd was neither answerable to Nature, nor was it a Confirmation of the Doctrine for which it is alledg'd; that it is not agreeable to Nature is evident, 1<sup>st</sup>, because if *Z*, the common Centre of Gravity either falls in *DO*, or near it, towards *E*, or towards *C*, the Colour compounded will neither be a Red nor a Violet, (which yet, according to this Rule, it ought to be) but a Purple: 2<sup>d</sup>, Because if only 2 of the Primary Colours, which in the Circle are opposite to one another, be mixt in an equal Proportion, the common

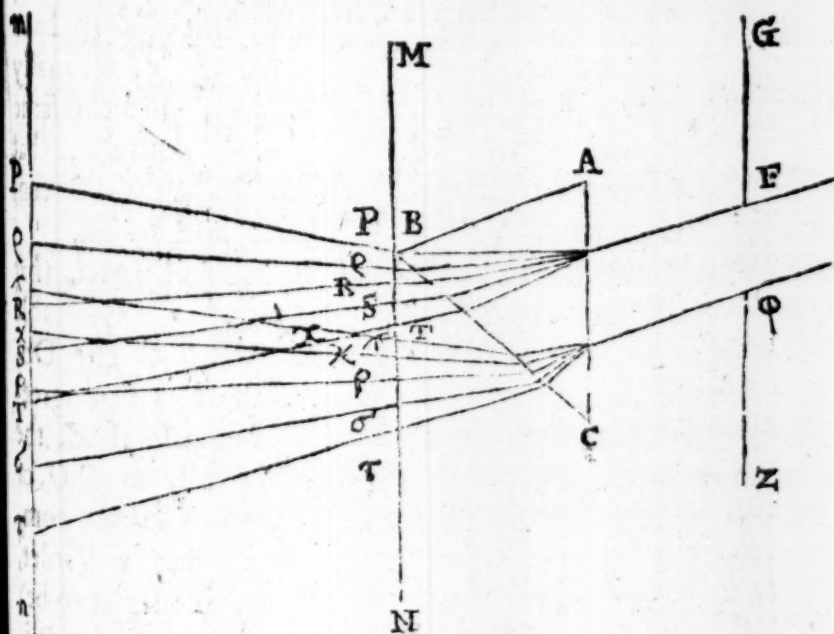


common Centre of Gravity will be in O, and therefore, by this Rule, two Colours only should produce a White; whereas the Composition of two Colours was never known to do it, and in other Cases 3, 4, 5, or 6 Colours should compound a White; whereas, in Nature, it is acknowledg'd, that the Mixture of all the Primary Rays is necessary to that Effect.

§. 24. Nor, if it were exact, would such a Rule be any Proof or Confirmation of the present Doctrine of Light and Colours, seeing, as we have already shewn, Light's being compounded by the Mixture of all sorts of Colours, is no Argument that it originally consisted of 'em, and the same is true of any other Composition, viz. of Blue, or Red, or Orange; for, after the Homogeneal Colours are once produc'd, their Mixtures will have the same Effects and Properties, by whatever means the Primary Rays of them came to exist, that is, Whether they originally were in Light it self, or whether they were form'd or modify'd into Colours by Refraction.

§. 25. In order to explain the Colours of Prisms,

*The Phenomenons of one Prism only, propos'd. Sir Isaak Newton's Opt. Prop. 8. Par. 2. Book 1. Fig. 12.*



the Figure annext is made use of, in which *ABC*, is the

the Prism,  $F\phi$  an Inlet, thro' the Window-shut  $GZ$ , to the Rays of the Sun, almost as large as the Breadth of the Prism. First, let  $MN$  be a Paper oppos'd to the refracted Rays, and the Appearance upon it will be a Series of Colours from  $P$  to  $\tau$ , rang'd in the following Order, namely, Violet, Indico, Blue, Very Faint-green, White, Faint-yellow, Orange, Red. Second, If it is held in the point  $X$ , the White vanishes, and the Colours meet. Third, If the Paper is held still more remote from the Prism, a fuller Green, Yellow and Blue, are produc'd than before.

*The Phenomenons of one Prism only, as explain'd by this Philosophy.*

§. 26. The first Experiment is accounted for, by supposing, the same Prism refracts two different Streams of Light,  $F$ , to  $PQIRST$ , and  $\phi$ , to  $\pi\chi\epsilon\sigma\tau$ ; as also, that the most refrangible, or deepest Violet Rays, extend themselves thro' the Space  $P\pi$ , the middle sort, betwixt the Indico and Blue Rays, thro' the Space  $Q\chi$ , the Middle sort of the Green Rays thro'  $R\epsilon$ , the Middle sort betwixt the Yellow and Orange Rays thro' the Space  $S\sigma$ , and other Intermediate sorts thro' Intermediate Spaces, and the least refrangible, or the deepest Red Rays thro' the Space  $T\tau$ ; by which Means the Interval, betwixt  $T$  and  $\pi$ , will be illuminated by all the Colours, and therefore White, but those betwixt  $P$ ,  $T$ , and  $\pi$ ,  $\tau$  will not, and will be consequently colour'd; particularly at  $P$  the Rays will be the deepest Violet, being the outmost of the most refrangible betwixt  $\pi$  and  $P$ , and with which no others are suppos'd to mingle; at  $Q$ , where the Violet ones, which lye betwixt  $P$  and  $\pi$ , are mixt with the Indico at  $Q$ , the Rays will be chiefly Indico, with a Composition of the Violet; at  $R$ , where the Violet which extend from  $P$  to  $\pi$  and the Indico, which are dispers'd from  $Q$  to  $\chi$ , and Blue, are mixt with one half of the Green Rays at  $R$ , their Colours by the foregoing Rule of the Composition of them, will produce a middle one between Indico and Blue;

Blue; at *S*, where all the Rays are mixt, except the Red and Orange, their Colours by the same Rule ought to compound a Faint-blue, inclining more to Green than Indico, and from *S* to *T*, this Blue will grow more faint and diluted, till it ends in Whiteness; on the other side of the White at *r*, the Colour will be the deepest Red, since the least refrangible Rays ly betwixt *T* and *r*, and at *r*, are the outmost with which no other colour'd Rays are united; at *σ*, the Red, which are incident from *T* and *r*, joyning with the Orange at *σ*, will compound a Red inclining to Orange; at *ε*, the Red, Orange, and Yellow, with one half of the Green, make up a middle Colour, between Orange and Yellow; at *χ*, all the Colours, but Indico and Violet, will compound a Faint-yellow, verging more to Green than to Orange, and this Yellow will grow more diluted from *χ* to *π*, till it ends in Whiteness. Lastly, it is said, these Colours ought to appear, were the *Sun's* Light perfectly white, but that being ting'd with Yellow, and mixing with the Faint-blue, between *S* and *T*, it changes it to a Faint-green.

§. 27. How imperfect this Solution is, we shall endeavour to shew, in the several parts of it; 1<sup>st</sup>, It supposes two Streams of Light, to be refracted thro' the same Prism, distinct from each other, one of which is transmitted near to its Basis, and the second not far from its refracting Angle; on the other hand, why *F φ* should not represent one individual and undistinguish'd Column of Light, and obtain the same Properties in its being refracted with either of these alledg'd, is not the least evident; since both the Orders of Rays in the former Experiment, §. 11, 12. could not be produc'd, unless by the Intervention of two Prisms, and it is not farther agreeable to Experience, that the Basis or the Planes next to it, as we observ'd before, should re-  
fract Light into Colours at all.

*The preceding Solutions invalid, in supposing two Orders of Rays refracted thro' the same Prism, which are not accounted for.*



*Invalid, because the Distances are arbitrarily assum'd.*

§. 28. If these two Streams of Light, and their separate and independent Refractions were granted, it is moreover plain, that the Distances of them are arbitrarily assum'd; for if they were as near to each other as  $B$  to  $c$ , Fig. §. 11, and the Reasoning was the same,  $P\tau$ , by an equal Mixture of the colour'd Rays, would be as well diffus'd into a White in this, as  $PT$  in that, and so the Colours in  $mn$  would disappear.

*The two Orders of Rays are not suppos'd to be refracted to the same extent in the present Experiment, as in the former.*

§. 29. It is likewise remarkable, that in the Account given in the former Experiment, the most refrangible Rays in the upper Prism, extend from  $M$  to  $P$ , Fig. §. 11. and in the lower from  $P$  down to  $N$ , and so of the rest; that is, where any colour'd Rays determine, from the Refractions of the upper Prism, they are from thence continu'd to  $N$ , by the Refractions of the lower, so that the Rays of each Colour are at least spread the whole Length of the Sides of the Prisms  $CB$ ,  $cb$ , and sometimes beyond it; whereas in the present Case, neither of the Lights in  $F$  or  $\phi$ , tho' one is incident near the Basis, and the other towards the Angle of Refraction, are suppos'd to be refracted to the same Extent, since  $P\tau$  is here presum'd to be the utmost Latitute of the deepest Violet, or the most refrangible Rays, notwithstanding that before they reach'd from  $M$  to  $P$ , and from thence to  $N$  Fig. §. 11. and the same Parallel holds concerning the other Intermediate Rays, till we come to the least refrangible, which ly from  $T$  to  $\tau$ , tho' before they diffus'd themselves from  $P$  to  $N$ , in the Figure cited.

*This Solution do's not agree with the Rule before laid down for the compounding of Colours.*

§. 30. Omitting this Arbitrary Mixture of the Rays, when compar'd, which is manifestly nothing else than an Ingenious Contrivance, by what has been said, to make the Composition of them, as far as is possible, answer the Appearances in Nature; yet we farther affirm, that this Elaborate Mixture of them do's not solve the Effect, which it is intended to do; or if it did, we cannot think that the Rule of Compounding them is certain

rain or true: We shall therefore consider the last in the first place; at R, the Violet Rays, the Indico, and the Blue are mixt with one half of the Green, which, by the aforementioned Rule, produce a middle Colour between Indico and Blue; by the same Rule at S, all the Rays, except the Red and Orange ones, being mixt, ought to produce a Faint-blue, inclining more to Green than Indico. If therefore the Rule, by which these Compositions are made, is fallible, and uncertain, as we have prov'd, the Reasoning, which is made use of from it, cannot be just.

§. 31. Let this be also allow'd, that such a Rule of Compounding Colours is infallible and determin'd, the Series of them, from P to r, by this Account, will be Violet, Indico with a Tincture of the Violet, a middle Colour between Indico and Blue, and a Faint-blue inclining more to Green

*The Solution do's not agree with the Colours found in the Experiment.*

| A                 | B                                                |
|-------------------|--------------------------------------------------|
| Violet,           | Violet,                                          |
| Indico,           | Indico and Violet,                               |
| Blue,             | A Colour between Indico and Blue,                |
| Very Faint-Green, | Faint-blue, inclining more to Green than Indico, |
| White,            | Fainter Blue,                                    |
| Faint-yellow,     | White,                                           |
|                   | Very faint Yellow,                               |
|                   | Faint-yellow, verging more to Green than Orange, |
| Orange,           | A Colour between Orange and Yellow,              |
| Red.              | Red, inclining to Orange.                        |
|                   | The deepest Red.                                 |

than Indico, a fainter Blue, White, very faint Yellow, Faint-yellow, verging more to Green than Orange, and a middle Colour between Orange and Yellow, a Red inclining to Orange, the deepest Red; But in the Observation they are Violet, Indico, Blue, very faint Blue, very faint Green, White, Faint-yellow, Orange, Red, from whence it is manifest, by comparing of them, that they differ in several respects.

A represents the Colours found by Experiment, and B, those which are deduc'd from this kind of computing them.

As

As to the Number, there are only 4 distinct Colours above the White, and 3 below it in the first Case, and in the last 5 above, and 5 below it, which how the one can be reconcil'd with the other, is not easy to explain; as to the Sorts of Colours, there are not above two that exactly agree, namely, those of the most refrangible Rays, and those of the least, the Violet and the Red; in the other Colours, for Indico, on the one hand, we have Indico and Violet on the other; for Blue, Indico and Blue; for very Faint-gree, we have a Faint-blue, which, instead of a Green, verges afterwards to a fainter Blue; for a Faint-yellow, we have a very Faint-yellow, and another, verging more to Green than Orange; for Orange, we have a Colour betwixt Orange and Yellow, &c. nor can it be affirm'd, in Vindication of this Reasoning, that the sorts of Colours are on both hands nearly Analogous, and alike, since there is an evident Green in one Case, for a Blue in the other, which is endeavour'd in this Philosophy to be accounted for, and if it could be, none of the rest are, which are as much different from each other as they, a Yellowish Orange, in particular, from Orange, Indico, from Indico and Violet, and Blue, from Blue and Indico, and so of the rest.

*If the Faint-blue in the Computation is answerable to the Green, in the Experiment, upon the account of the Yellow in the Sun's Rays, the same Yellow would cause a proportionable Alteration in the other Colours.*

§. 32. To explain therefore how the Faint-blue, in the Computation, should be answerable to the Green, in the Experiment, it is said, That the Colours under *B*, are thus calculated, upon the Supposition of Light being perfectly White; but since the Solar Light is of a Yellowish Colour, it will draw the Faint-blue to a Green, suitable to what is observ'd in the Colours under *A*: If this were so, it is reasonable to think that all the other Colours would find a proportionable Alteration, and that even the Whites themselves would be either Yellow, or the one would be Yellow, and the other White; that the Violets, the Indicos, Oranges, and the Reds, would also put on another Appearance than what is here affirm'd, since the whole,

it



it seems, is adjust'd upon the Supposition of the Rays being White, and not Yellow; if theretore, upon that Supposition, the Blue will differ from the Green, and all the other Colours agree, on the contrary Supposition, it is necessary, that the Blue should agree with the Green, and all the other Colours differ.

§. 33. The Second Phenomenon in the Prism is, That if the Paper is remov'd from the Prism to the Point *X*, where *TT*,  $\pi\pi$  unite, the intermediate White vanishes, which would certainly follow, if it was true that two Streams of Light could be refracted in that manner, which is here affirm'd; the contrary of which, from what has been hitherto offer'd, seems to be apparent, altho', we would also think, that, the Solar Rays being Yellow, the Intermediate White, which vanishes, should rather be call'd the Intermediate Yellow, which would agree but illy with this Second Phenomenon of an Intermediate White.

*The Intermediate White, according to this Doctrine, ought to be an Intermediate Yellow.*

§. 34. The Third is, that upon a farther removal of the Paper to *mn*, a fuller Green, Yellow and Blue, are produc'd than before, which is said to proceed from the most refrangible Rays, and the least refrangible Rays being wanting in the middle of the Light, that is from  $\pi$  to *T*, which are the Boundaries of each of 'em, and therefore the rest of the Rays, which are found there, will cause by their Mixture a fuller Green, also the Yellow and Blue, being less compounded than they were, are by consequence more intense; as to the Green, there will be a Mixture of the Indico, Yellow, and Green to produce it, if it lies betwixt  $\pi$  and  $\pi$ , and if that Space is possess'd by the Green, it will be difficult to find a place for the Yellow and Blue, on either side of it, where only the Violet and Blue are found extended from *P* to  $\pi$ , and the Red and Orange from *T* to  $\pi$ .

*A fuller Green, Yellow and Blue produc'd, upon a farther removal of the Paper, not accounted for.*

§. 35. If therefore in looking thro' a Prism upon a White Object surrounded with Black, the reason of the Colours arising on the Edges, is much the

*If the foregoing Phenomenons are not solv'd, it is unlikely*

*the others mention'd in this Philosophy should be.*

Sir Iſ. Newt. Opticks, Prop. 8. and Exper. 16. Par. 2. B. 1.

the ſame with that of theſe Prismatick ones, ſince theſe are unexplain'd, thoſe muſt be equally ſo; and upon the like Account, the Colours made by the Glaſſes of Telescopes, or Microscopes, or by the Humours of the Eye, are unſolv'd, which we ſhall not now particularly inquire into, nor yet that Blue, which is obſervable from the Reflection of the Priſm, which as it is ſaid to be incapable of a Solution, from the Vulgar Hypotheſes of Philoſophers, ſo we cannot think it is better explain'd by the New one; we ſhall therefore, after having examin'd into the Colours of the Priſm, go on to the Celebrated Theory of the Rain-bow, which Doctrin we ſhall conſider in the enſuing Chapter.

## CHAP. VI.

*Concerning the Solutions of the Rain-bow, either from the Cartefian, or the preſent Principles.*

*The Hypotheſis of one reflection, and two refractions, to ſolve the Primary Iris, only worthy the conſidering.*

§. 1. **I**N examining into the ſtrange and admirable Properties of this Phænomenon, we ſhall, amongſt the ſeveral Hypotheſes alledg'd to explain them, ſelect that, which has at preſent the preference to the reſt, and is thought to approach very near to Mathematical Demonſtration, and which ſolves the Affections of the Primary Iris, by one Reflection of the Sun's Rays, and two Refractions, and thoſe of the Secondary, by a double Reflection, as well as Refraction of them.

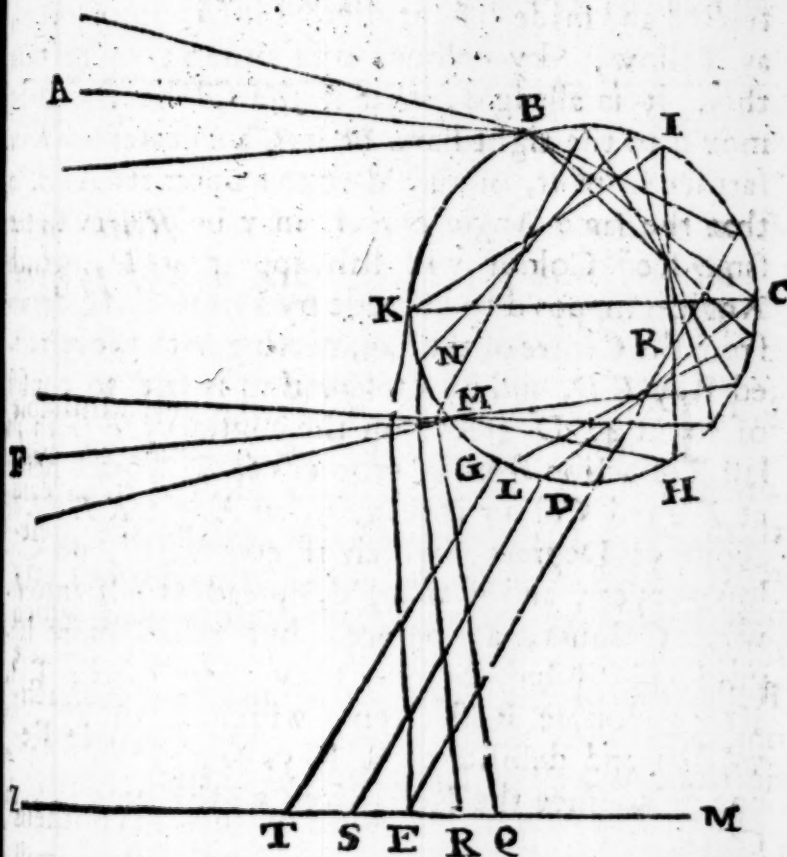
*The Foundation and Riſe of this Hypotheſis.*

§. 2. The whole Invention of this Hypotheſis is owing to an Experiment on Water, caſt in ſmall Drops into the Air, and forming a kind of Miſt oppoſite to the Sun, from whence a Bow will be ſeen, with all the Variety of Colours expreſs'd in the Iris. The Experiments of this Nature, of which

which there are several, we shall afterwards, if there is occasion, recount, and shew that they are not applicable to, nor do in the least confirm, but rather refute and contradict the present Hypothesis: These Experiments, however, Naturally led the Observers of them to inquire into the Properties of Water, and the Refractions and Reflections produc'd by it, and w<sup>ch</sup> probably was the Cause of the following Account given us of the Appearances of the Rain-bow.

§. 3. In this Hypothesis, it is therefore suppos'd, that *B C D* is a Globe of Water, inclos'd in a Glass-sphere, on which the Rays of the Sun fall parallel to each other, and to *Z M*, from *A* and *F*, to *B* and

*The Hypothesis is self explain'd*  
Sturmius's  
Thaumaf.  
Thaumantia-  
dos, Cap. 3.  
Art. 1, 2, 3.  
Par. 1.



*G*, *AB* is refracted to *C*, and from thence reflected to *D*, and at *D* is again refracted to *E*, where the Eye is situate; on the other hand *FG* is refracted to *H*, and from thence reflected to *I*, from *I* to *K*, and from *K* is again refracted to *E*;  
by



by the first, the Properties of the Primary Iris are explain'd, and by the last, those of the Secondary.

That the Rays of the *Sun* are thus refracted, and reflected, is prov'd, because if *AB*, *BC*, *CD*, or *DE* are intercepted, in any of these Cases, the Red, which is seen by the Eye in *E*, at *D* in the Globe, immediately disappears, and the same is experimented of *FG*, in its Course thro' *GH*, *HI*, *IK*, and *KE*; for if each of these are separately obstructed, the Red, which is seen at *K*, likewise vanishes: It is farther observable, that if the Angle *DEM* is enlarg'd, the Red at *D* is lost, and no Colours succeed into its place, but if it is contracted and made less, it divides it self into several, as Yellow, Sky-colour, and others; more than this, it is alledg'd, that if the Globe *BCD* be mov'd to the right hand or left, or nearer to *E* or farther from it, or turn'd round upon its Axis, so that the same Angle *DEM* may be preserv'd, the same Red Colour will still appear at *D*; which Angle is suppos'd to be made by a Line *ZM*, drawn from the Centre of the *Sun*, meeting with the refracted Ray *ED*, and by Observation is said to consist of about 42 Degrees; on the contrary, *FG* in its last Refraction from *K* proceeds to *E*, from whence at *K* a red Colour is seen, in an Angle *KEM*, of about 52 Degrees, which if contracted, no Colours appear, and if enlarg'd, spreads it self into several Colours, as before, but much more languid and diluted, because they come to the Eye after a double Reflection, which is thought to weaken and debilitate the Rays more than a single one do's, since the Refractions are the same in both Cases.

*A Second Account of this Hypothesis.*  
Thaumaf.  
Thaumant.  
Cap. 3. Art. 4.  
5, 6. Par. 1.

§. 4. This is one and the First Account, which is given us of the the Refractions and Reflections of Light thro' a Globe of Water, inclos'd in a Sphere of Glass; a Second is as follows: That Red appears at *D*, when the Eye of the Observer is in *E*

Yellow

Yellow at *L*, when the Eye is in *S*, and Green or Cærulean at *G*, when the Eye is in *T*; on the contrary, *K*, *N* and *M*, represent Red, Yellow and Green or Cærulean to the Eye, in *E*, *R* and *Q*, in the first Case the Angles made by the Rays with *ZM* are diminish'd, as they recede from that under which the Red appears, namely, *DEM*, and in the last, from *KEM*, in which the Red is likewise visible, tho' in a fainter Degree, the Angles increase.

§. 5. The Third Account, which we have of this Experiment, is, that at *E*, the Red appears, in *D*, at *S*, a Green, in *L*, and at *T*, a Violet or Purple, in *G*, betwixt *DE*, *LS*, a Yellow, and betwixt *TG*, *LS* a Blue, and the like is affirm'd at *K*, *M*, *N*, and betwixt *KN*, and *MN*, from the several Stations of the Eye in *E*, *R*, *Q*, and their Intermediate Spaces, excepting that the Colours are more languid.

§. 6. In answer to which Hypothesis, we are to take Notice, that a Globe of Water is fundamental to it, and therefore the Medium, on which the Bow is painted, must consist of an infinite Number of small Globular Parts, which resolves it self into the Corpuscular Philosophy, and upon that account may be justly disputed.

§. 7. If yet the Corpuscular System was allow'd of, it will not be certain that Rain falls in parts which are Globular, since altho' a Drop of Water is form'd into a Sphere, by the Air which surrounds it, yet where there is a continual Current of the same Fluid in Air, it may be rather press'd to constitute a Cylinder, than a Globe, unless the parts of Water do originally assert that Figure to themselves, which, even in the Corpuscular Philosophy, is not prov'd, for it sometimes supposes them to be Oblong, by which means they may easily slide over one another, and at other times Spherical, because in the Air they appear to be so.

§. 8.

*A Third Account of it. Thaumaf. Thaumant. Cap. 3. Art. 7, &c. Par. 1.*

*Small Globes of Water requisite to this Hypothesis, and therefore the Corpuscular Philosophy is so.*

*Not certain that Rain, or Mist, falls in Portions of a Spherical Figure.*

*If this Hypothesis was true, upon every Shower, and the Opposition of the Sun to it, a Bow ought to appear, which is not experienc'd.*

*This Hypothesis supposes Globes distinct from each other, which is impossible to conceive, whereas the Bow is continued without Interruption.*

§. 8. We shall, however, after what has been said, imagine them to be Globular; if so, when therefore Rain falls, and the *Sun* shines from an opposite Quarter, directly upon them, a colour'd Bow ought to be produc'd, whereas no such Appearance is observable, whilst the Gross and Thick Drops of Rain are in their passage thro' the Air, but after they are fallen, and when there is nothing remains but a thin Moisture, spread and diffus'd thro' the Medium they have left.

§. 9. If it is affirm'd, that this diluted Substance consists of infinitely small Globes of Water, which are distinct from each other, without any Confusion of them into various and different Figures, we may justly deny such an Assertion on two Accounts; 1<sup>st</sup>, because it is altogether inconceivable, how any two or three Globes of Water, which touch one another, should not coalesce into one, since it is not known by any Experience, where one or two Drops of Water were added to a third, that they did not unite into the same Substance; 2<sup>d</sup>, because we may as well and as truly suppose, that even Water, or a Cloud of Rain, would exhibit the Appearance of the Iris as such a System of Globes, if we should stand betwixt it and the *Sun*, and are so far above or below the one or the other, that the reflected Rays should with the incident comprehend the Angles before determin'd; and therefore in a certain Position of the Eye, we should see a Bow in a subjacent River, or in an Impending Cloud; since in this Hypothesis all the Rays of the *Sun*, where-ever they fall, are imagin'd to be parallel, and a Cloud, or Water consists of Globes, according to the Corpuscular Philosophy, which must refract and reflect the Rays in some Situation of the Eye or other, and of the *Sun*, with the same Laws and Conditions, which are here specify'd, but we do not find any such Appearances in Nature; we cannot here but add



add what an Ingenious Young Gentleman, at present of this College, did me the Honour to shew me, in the Chamber where I now write this, which was a Circle round the *Sun*, with all the Colours of the Rain-bow, and which will be but illy accounted for, upon the present Hypothesis, for it was seen in all Situations of the Eye.

§. 10. Besides, if it were possible for these Imaginary Globes of Water to touch each other in a Point only, and to keep a Distance as regular, in respect of the rest of their Superficies, as if they were inclos'd in Spherical Glasses, which to one, who considers, cannot but be a very hard and gross Concession, they are yet presum'd to be infinitely small, or not; if they are, it is the same thing, as if so many Individual Points were set together, which would make one confus'd and continu'd Mass, and consequently there would not be Space sufficient, in which the Distinct Refractions and Reflections might be perform'd, they would all terminate in a Point, and become, without any Refractions, one Reflection only; if they are not infinitely small, there will be certain Intervals and Interstices betwixt them, and each Globe will have its particular Refractions and Reflections, agreeable to what is describ'd to us in the Globe *BCD*, in the former Figure.

§. 11. But then there will this Inconvenience follow from such a Supposition (see the following Figure) that at *D* and *K* Red will appear, but in *LB*, *ZL*, the Angles *BEM*, *LEM*, being different from *DEM* or *KEM*, there will be no such Phænomenon; from whence it will be consequent, that, in the Primary and Secondary Iris, *D* and *K* are the only places of Red, and the same may be said respectively of the other Colours, altho' it is acknowledg'd, that several Globes are requisite to the forming of them, that is, by this Experiment there is only one Globe *BCD*, which

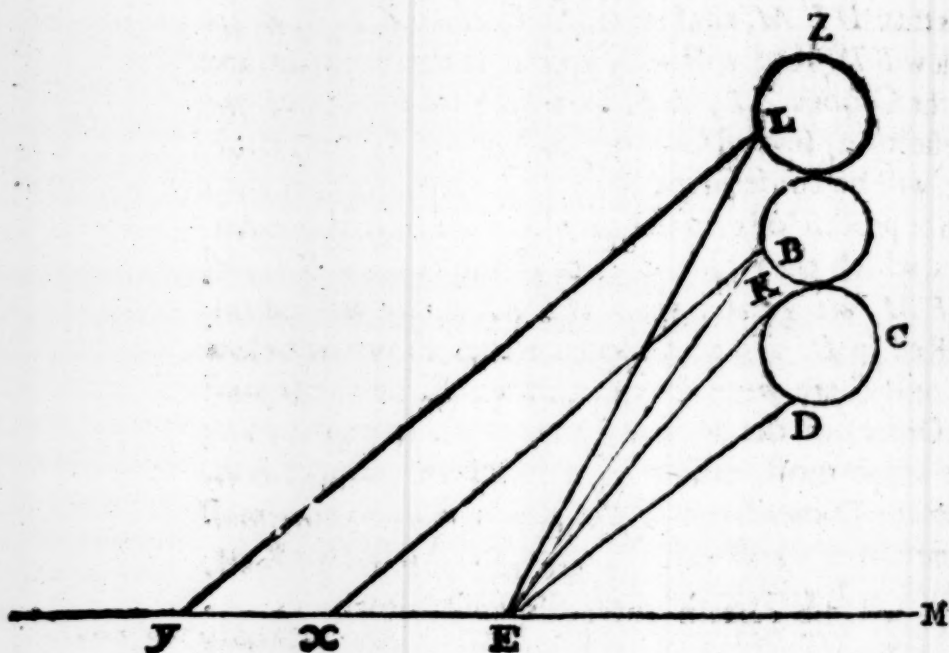
*If the Globes were distinguished from each other, and infinitely small, there would be only a Reflection in a Point.*

*If the Globes were distinguished from each other, and of a Definite Bigness, the Colours could be only seen from those Globes in the same Circumference of the Basis of the Cone drawn from the Eye, plac'd in the which Apex of its*

which can exhibit the varying Colours to the Eye at *E*, and yet the Iris which exhibits those Colours, is suppos'd to consist of several Globes, which is a Contradiction.

The preceding  
Arguments ex-  
plain'd.

§. 12. To make this more evident, let us consider *DEM*, as the Angle under which Red is seen, in the First Globe *BCD*, if we therefore



take the next above or below it, for Instance, *LB*, and draw a Line *BX* parallel to *DE*, and from *ZL*, *LY* parallel to *XB*, Red for the same Reason will be seen in each of these, that is in *L* and *B*; and therefore if the Medium, upon which the *Sun's* Rays are incident, do's consist of several Globes of Water one above another, it is necessary, if the Eye can receive all the Rays betwixt *T* and *E*, that there should be the utmost Confusion of Colours, and nothing answerable to the Phænomenon of the Rain-bow; since the Red in the Primary Iris will appear in different Places in *D*, *B*, and *L*, with several intermediate Colours betwixt them, and the Red of the Secondary Iris *KE* will appear within the Limits of the First, *L*, *B*, and *D*.

§. 13. What makes this Doctrine more disputable, *If this Doctrine were true, the Colours would not appear in that Order in which the Bow represents them.* is, that, on the other hand, it cannot be deem'd, that the Eye should receive all the Rays betwixt  $\gamma$  and  $E$ , when it is only suppos'd to be situate in  $E$ , or if they reach to the same Point  $E$ , it is not certain that the Distinct Colours of the Iris will be seen from  $B$  to  $L$ ; for supposing the Angles  $BEM$ ,  $LEM$  are less than  $DEM$ , that is, if the Globes  $ZL$ ,  $LB$  are below  $BD$ , Red will only appear at the Point  $D$ , and in the Globes  $ZL$ ,  $LB$ , in which there is only one Reflection, several Colours, as Yellow, Green, Blue, &c. will be consequent upon such a Situation, if they can be produc'd from the bare Diminution of the Angles, which they cannot; but if the Angles  $BEM$ ,  $LEM$ , are greater than  $DEM$ , there will be only Red in  $D$ , and no Colours either above or below it, or if there were above, Red would be the lowest in Order, in the Primary Iris, when it ought to be the Uppermost, either of which Cases would contract the Dimensions of the Rain-bow, to the small Limits of one Individual Globe, in a Mist after Rain, which is Extravagant and Inconceivable.

§. 14. For besides, if we Reason Abstractedly from these Globes, it is evident the Red, Yellow, Green, Blue, and Purple in the Iris take up some Latitude in their several Extents, which it is impossible they should do, if the Red was visible in one certain Angle only of about 42 Degrees, and the other Colours, agreeably to it, asserted their peculiar Angles, under which they chose to be seen: This Latitude of the several Colours, at least, is inexplicable, from the foregoing Doctrine, as has been prov'd in the 11, 12, 13 Sections, in respect of the Primary Iris, and the same Demonstrations may be easily apply'd to the Secondary. *Nor in the same Latitude and Extent.*

§. 15. Having consider'd what would be the Effects of different Globes of Water, we shall now examine into the Properties of one only, as they are represented to us in the Figure express'd in §. 3d. *Several Reasons against the Reflections, asserted of one First, Globe only.*



First, therefore, supposing the Rays to fall from  $A$  to  $B$ , they are from thence imagin'd to be refracted to  $E$ ,  $S$ , and  $T$ ; in which Account it is both admirable and unexplain'd, how the Rays which enter the Globe, in the same Point at  $B$ , should upon their Egress, refract in different ones  $G$ ,  $L$ , and  $D$ , which yet it is necessary they should, if  $D$ ,  $L$ , and  $G$  import different Colours to the Eye; for if the Rays diverge from  $B$  towards  $A$ , as in the present Figure, they are not parallel, contrary to the Supposition; if they do not diverge, they do not enter at the same Point, contrary to the Scheme. And lastly, if they are parallel, and enter at the same Point nearly, their Refractions would arrive at the same Point  $C$  nearly, and consequently their Reflections would come to  $L$ , with little or no Distinction; 2<sup>d</sup>, It is surprizing, upon the same Account, that, in the Refraction from  $B$  to  $C$ , the Rays, which are parallel, should diverge from the Point  $B$ , and in their Reflection from  $C$  to  $L$ , or, which is all one, in their retrograde Refraction from  $L$  to  $C$ , they should converge to a Focus in  $R$ , and from thence diverge to  $C$ . 3<sup>d</sup>, It is as unreasonable to presume the Rays  $A$  to fall from the *Sun* parallel to  $ZM$ , and yet to be refracted (from the same Glass, or Water, on which they were incident, after a Reflection at  $C$  in equal Angles) in Lines not parallel to  $ZM$ , but forming the Angles  $DEM$ ,  $LSM$ ,  $GTM$ , the greatest of which amounts to near 42 Degrees, this seems to be unreasonable, if the Refracting Globe is suppos'd extremely, and almost infinitely Minute, since in such a Case, the Point  $C$  will fall within the Diameter  $KC$ , the Difference betwixt  $C$  and the Points of Reflection being infinitely small. To conclude, if the Rays could be refracted to  $S$ , and  $T$ , since the Eye is suppos'd to be in  $E$ , and cannot receive those others from  $L$  and  $G$ , unless by altering its Situation into the Lines  $SL$ , and

$TG$ , that is, by elevating of it to different Situations, or carrying it in the same Horizontal one, from  $E$ , to  $S$ , and  $T$ , or else by depressing the Globe  $BCD$  towards  $M$ , it is evident, that this Phænomenon can afford us no Explanation of the Rain-bow, whose Colours are visible in one certain and fix'd Position of the Eye at  $E$ .

§. 16. If it is affirm'd, that the Angles  $DEM$ ,  $LSM$ ,  $GTM$  exactly correspond with those under which the several Colours in the Rain-bow, by Observation, are seen; We answer, That is neither true, by what has been said in §. 13, 14, from Reason, nor is it true in Observation, since the Angle  $DEM$ , in particular, has been found to be various from 40 Degrees 50 Minutes to 42 Degrees, which is a greater Latitude belonging to the Red, than is in this whole Experiment from  $D$  to  $G$ , within which Limits all the Colours of the Rain-bow are suppos'd to be exhibited and form'd.

§. 17. What is alledg'd in the foregoing Sections, is upon the Supposition of a double Refraction, and a single Reflection of the Rays, which proceed from  $A$  to  $B$ , whereas that also may be lastly disputed; for the Globe  $BCD$  being suppos'd of one Uniform Consistence, since at the several Limits of this Substance  $B$ ,  $G$ ,  $L$ , and  $D$ , there is a free Ingress and Egress permitted to the Rays, why at the Point  $C$  in particular they should be intercepted, and reflected to  $D$ ,  $L$ , and  $G$ , when the Nature and Constitution of the Globe, in all Reason, ought to be the same at  $C$ , as at  $B$  or  $D$ , and when in both Cases it is bounded with the same Medium of Air or  $\text{Æther}$ , will be a Difficulty not to be surmounted in the present Hypothesis; seeing it is not sufficient to say that there are certain Solid Parts at  $C$ , whereby some Rays are reflected, whilst others are transmitted: Because altho' the Globe  $BCD$ , should be revolv'd on its Axis, the same Phænomenons will obtain, and consequently the

*A greater Latitude belongs to the Red, by Observation, than this Doctrine allows to the whole Rain-bow.*

*A Double Refraction, and Single Reflection, not certain in it self, tho' hitherto granted.*

same Reasoning will be necessary, if this Hypothesis is true: Let therefore *B* in its revolution be plac'd in *C*, and it will follow, that the very same Rays which pass at the Point *B*, in the first Position, will be reflected by it in the second, that is, the Point *B* in the Globe *BCD*, do's and do's not resist the Rays of Light, as this Philosophy shall find it the most convenient for its Solutions, and the like may be affirm'd of the Points *G*, *L*, *D*.

*The same Double Refraction, and Single Reflection, not certain upon a Second Account.*

§. 18. Another Objection, is, That it seems to be extremely Arbitrary, as well as Absurd, to suppose the Circumference of the same Fluid *BCD*, to consist every where of Parts, which are both Solid and Fluid; it is Arbitrary, because it is evidently done with a Design to let the Rays pass, or to obstruct them, as the Phenomenon shall require; and it is Absurd, because not only the Circumference, but the whole Contents of the Globe, will be resolv'd into Fluid Parts, according to this Doctrine, with Solid ones, every where intermix'd with them, and by that means the Rays *BC* will not be reflected at *C*, but in every Step of their Progress from *B*, and consequently will never arrive at *C*; for why they should be reflected at *C*, and not in a Million of Points, which lie betwixt *B* and *C*, is inconceivable; not to mention the Contradiction of a Fluid Body's consisting of Solid Parts, since we have consider'd that before in our Examination into the Principles of the Corpuscular Philosophy: If it be said, that the Shadow which lies behind *BCD* reflects the Rays, it is no more than to affirm, the Rays are reflected, because they are not transmitted, Shadow, or the Absence of Rays, proceeding only from the Rays not being transmitted at *C*.

*Why two Refractions and Reflections should be necessary in the Secondary*

§. 19. If all this were false, which we have argued, there could be yet no Reason assign'd wherefore the Rays *AB* should come to the Eye, after one Reflection only, whereas the Rays *FG*, which are parallel



parallel to them, are oblig'd to perform two Reflections, before they reach to the same Point *E*, the Contrivance is manifest, namely, to bring down the Rays of the latter to the Eye of the Spectator, which would otherwise pass on above it, and not fall under any Observation; the Artifice, I say, is evident, but the Reason is not; on the contrary, the Rays *AB* in their passage thro' the Globe *BCD*, subtend different Archs from those of *F*, in their several Reflections, that is, *GH* is either less or greater than *GC*, and so of the rest; if not, *GH*, *HI*, *IK*, are respectively equal to *BC*, *CD*, and consequently, as the Latter observe all the Conditions of the Former, subtend the same Archs, and fall with the same Incidences on the Circumference of the Globe, since the Individual Rays express'd at *I* are reflected to *K*, the Individual Rays express'd at *D*, *L*, *G*, ought likewise in reason to be reflected to *K*, and therefore not to proceed to *T*, *S*, *E*, according to what is here imagin'd; nor can this Argument be evaded by saying, that at *G*, *D*, *L* some Rays may be transmitted, and others reflected, since by the same Reason the Individual Rays, which would have been transmitted at *G*, *L*, *D*, may be transmitted at *C* or *H*, and consequently the Colours of the Rainbow seen behind the Globe, as well as before it, and under different Angles, from those which are asserted by this Hypothesis: Besides, if that loose and uncertain way of Arguing was allow'd, which would have some Rays to be transmitted, and others in their Passage repuls'd, without determining from Reason, which were submitted to this or that Law of their Acting, it would be a lucky Chance indeed, that there should be just so many Rays transmitted at *G*, *L*, *D*, as were reflected to *K*, *N*, *M*, at *I*; on the other hand, if *GH* is not equal to *GC*, &c. but is less or greater, it will be altogether unaccountable, how the Rays at *AB* should be refracted differently from those of *FG*, where the Incidences of both in the

*Iris, and not in the First, the Artifice is plain, but the Reason not so.*

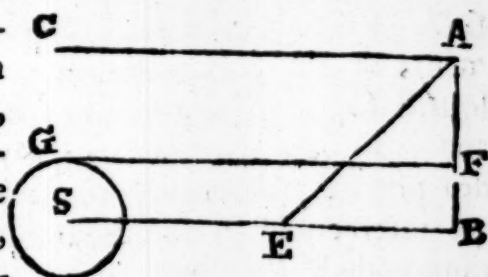
Schemes, which are given us, are represented to be only not parallel, but on like Parts of the same Globe *B* and *G*, and all other Conditions of the Globe are equal.

*This Doctrine  
not prov'd from  
Experiment.*

§. 20. It may said, notwithstanding, that these Reflections are so apparently prov'd from Experience, that it would be an Instance of the greatest Perverseness and Folly to deny them; since if the Rays are intercepted at *B*, or betwixt *B* and *C*, or *C* and *G L D*, the Colours vanish, and are not seen at *T S E*, if this Experiment were exactly true, it would indeed be a convincing Proof of such Reflections in a Globe of Water, but nevertheless would not be one, by what has been already advanc'd, of the like Reflections in the Rain-bow; and as to what concerns this particular Progress of the Rays in a Globe of Water, inclos'd in a Glass Sphere, we cannot be certain of it from these Experiments, unless it is prov'd, that any Obstacle thrust into the Globe of Water in other Parts, as betwixt *B C I*, or *H C D*, as well as betwixt *B* and *C*, will not disturb it, nor destroy the Colour'd Appearance at *G L D*; for it is not sufficient to say, that it will do it in *B C*, if it is not at the same time affirm'd, that it will not do it in any other Parts, betwixt *B C* and *B I C*, or betwixt *D C* and *H D C*; but that it will do it in some measure out of the Lines *B C* and *C D*, we have, from other Analogous Experiments of the Refractions and Reflections of Colour'd Light thro' a Prism, some reason to believe, and is in part acknowledg'd by this, since it do's not precisely determine the Rays *B C*, *C D*, which are intercepted in the Experiment, and therefore cannot shew that they in particular are intercepted exclusive of others, which lie betwixt *B C* and *B I C*, *C D* and *C H D*. That farther which confutes this whole Doctrine, and all the Reasonings upon it, is, that no Colours can be produc'd from the Refraction of Rays thro' the Body of the Globe,

Globe, which only are so by their Refraction thro', or Reflection from the extreme parts of it, as was observ'd in our Examination into the Doctrine of the Prism, which also produces Colours by the Edges of it, and those Parts, which ly nearest to them.

§. 21. Another Objection against this Hypothesis, is, that the Rays of the *Sun* are suppos'd to fall on the Globe *BCD*, Fig. §. 3. parallel to *ZM*, the Line drawn from the Centre of the *Sun* to *E* or *M*. Whereas if *AB*, *FG*, *ZM* are parallel, they will fall infinitely near each other, by reason of the infinite Distance of the *Sun* from the Globe, or not; if they do, *A* and *F* may as well be consider'd to be in Lines drawn from the Centre of the *Sun* as *Z*, that is, they will coincide with each other, and the Angles of Refraction and Reflection, and this whole Contrivance will vanish into one Uniform Line, represented by *ZM*, and the Globe *BCD* will be no more than one single Point, which will fall in with *M*. If *AB*, *FG*, *ZM* do not approach infinitely near to each other, by reason of the *Sun*'s Distance, supposing *ZM* to be the Line drawn from it's Centre, either *AB* the remotest Parallel from it, which is produc'd from the *Sun*, will be at the Interval of half its apparent Diameter, which is about 16 or 17 Minutes of a Degree, contrary to Experience, since the Globe, or the Rain-bow, are plac'd at a much greater height, or else *AB*, the remotest Ray from the Centre of the *Sun*, will, if extēded backwards from *B* to *A*, fall above the *Sun*'s apparent Diameter, and so will not be a parallel Ray deriv'd from it. Thus where the Eye is at *E*, in the present Figure, and the Elevation of the Object is *BA*, if, by reason of the infinite Distance of the *Sun* *S* from *E*, *AB*, is not infinitely





finitely diminish'd,  $S$  will have its Effects suitable to its Appearance, and therefore will emit its Rays no higher than  $GF$ , and consequently  $CA$  will be a Ray, which will never meet  $GF$ , but always run in a parallel Course above it; that is, if  $SB$  is a Line drawn from the Centre of the *Sun*, and  $GF$  is parallel to it, and the Height of the Bow, or the Globe in the Experiment is  $AB$ , it will be impossible that  $A$ , according to this Hypothesis, should be irradiated at all; for  $SA$  will not be parallel.

*An Objection from the improbability of the Eye's receiving all the Rays in one station, according to the present Theory of Refractions.*

Thaumaf.

Thaumant.

Fig. 12. p. 70.

& Fig. 10. p. 6.

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§. 3. of this

Chapter.

§. 22. Lastly, In the Common and Vulgar Schemes, which are given us of the Refractions and Reflections of the Globe  $BCD$ , (Fig. §. 3.) the Rays  $KE$ ,  $NR$ ,  $MQ$ , are incident on the Left-hand of  $E$ , at some Distance from  $T$  towards  $Z$ , which in the present we have endeavour'd to contract from  $E$  to  $Q$ , notwithstanding, which, it is impossible to conceive how the Eye at  $E$  should, by one uniform View, and without the least Change of its Situation, comprehend all the Rays at once betwixt  $T$  and  $Q$ , which the Phænomenon of the Rain-bow requires; if we farther suppose  $QT$ , and the intermediate Rays, which ly betwixt them, to be reflected to a very minute Distance from  $E$ , by which means all the Colours might be seen at once in the Iris, and in their proper Order, according as the Angles at  $Q$ ,  $R$ ,  $E$  are bigger, which would lead the Eye to a higher Elevation of them in  $K$ ,  $N$ ,  $M$ , or  $E$ ,  $S$ ,  $T$  are less, which would direct it to a lower at  $GD$ , this yet would not agree with the Experiment, which supposes that we cannot see all the Colours at once, but by an Elevation of the Eye, or which is the same, by a Depression of the Globe.

*The Calculations upon this Hypothesis, the next thing to be consider'd.*

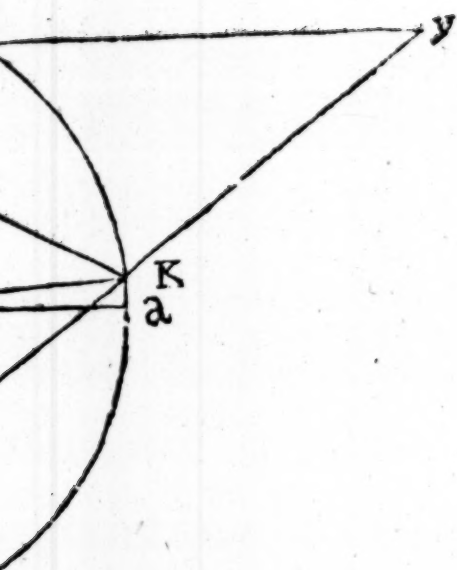
§. 23. Having thus far consider'd the several Parts of this Hypothesis, as to what concerns the Refractions and Reflections which it asserts, and the Globe which it assumes, in Order to produce them, as well as the Incidence and Parallelism of the Rays necessary

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necessary to such an Effect, we shall now proceed to inquire into the Mathematical Calculations upon it, and from whence it is suppos'd to be confirm'd beyond contradiction, after having observ'd, that these Calculations take for granted what has been hitherto disprov'd, and that therefore, altho' they were acknowledg'd to be just, they would only shew us, that, upon Concessions or Hypotheses which are false, true Conclusions may be made in a Reasoning, which is form'd and abstracted upon them, tho' not in a Reasoning agreeable and adequate to the Nature or the Reality of Beings themselves.

§. 24. Let  $CD$  be divided into 10000 Parts, to which let there be so many Incident Rays suppos'd to be drawn, parallel to  $EF$ , whose several progresses thro' the Globe, to their Refractions out of it, are inquir'd, and the ultimate Angle  $ONP$ , or  $NPV$ , made by the refracted Ray  $NP$ , and the Line produc'd from the *Sun's* Centre, to the Eye of the Spectator; for Instance, out of the 10000 Rays, let us select  $EF$ , whose Sine of Incidence  $FH = LC =$  to the Sine of the Angle  $CFL =$  to the Angle  $WFE$ , is 8000 of the same Parts of which  $DC$  has 10000; but  $CI$  is the Sine of the refracted Angle, and by the Laws of Opticks 250. 187 :: 8000.  $CI$ , which therefore will be 5984: Further, if  $FH$  is 8000, its Correspondent Arch  $FA$ , by the Tables of Sines, will be  $53^\circ. 8'$ , where the whole Sine is 10000, and consequently its Complement  $FD$   $36^\circ. 52'$ , and therefore the double of it  $FG$ ,  $73^\circ. 44'$ , from whence also the Arch  $FK$  is known; for  $FCA = CFL$  is  $53^\circ. 8'$ , the Sine  $CI$  is 5984, and by consequence its Correspondent Angle in the Table of Sines will be  $36^\circ. 45'$ , and this subtracted from the former Leaves  $16^\circ. 23'$ , = to the Angle  $KFG$ , of which, being in the Circumference, the Angle at the Centre  $GCK$  will be double, =  $32^\circ. 46'$ , and added to the Arch  $GF =$

73°

*The Method of Calculation upon the foregoing Hypothesis.*  
Cartes. Meteor. Cap. 8.  
§. 10. Thaum. Thaumant.  
Cap. 3. P. 139.

73°, 44', makes the Arch  $FK = 106^\circ, 30'$ . Lastly, subtract double the Arch  $FK = 213^\circ$ , from  $FG + GNX = 73^\circ, 44' + 180^\circ$ , and there will remain  $NX = 40^\circ, 44' = \text{Angle } ONP = NPV$ ; for  $CFK = CKF$  is  $= 36^\circ, 45'$ , and therefore  $FKN$ , which is double of the former, will be  $= 73^\circ, 30'$ , and  $FKY$ , the Complement of it to two right Angles  $106^\circ, 30'$ , but  $KFY$  is  $= 16^\circ, 23'$ , and consequently  $FKY, 57^\circ, 7' = NTU = ONT$ , from which subtract  $PNT = 16^\circ, 23' = GFK = BFE$ , and there remains  $ONP = 40^\circ, 44' = \text{Arch } NX$ .

In like manner,  $SQR$  is found after two Reflections, and two Refractions; for let  $EF$  fall on the lower part of the Globe, and every thing will proceed as before to  $N$ , from whence a second Reflection is made to  $Q$ , and the second Refraction to  $R$ ;  $KNQ$  therefore  $= FKN$  is  $= 73^\circ, 30'$ , as before, and  $NTU = 57^\circ, 7'$ , and consequently  $TUN = SQZ$ , is  $49^\circ, 23'$ : Add the Angle of Refraction  $RQZ = 16^\circ, 23'$ , and the Angle  $SQR$  will be  $65^\circ, 46'$ . From the foregoing Computation, the following Tables are deriv'd, for the same kind of Reasoning obtains in other Cases, as well as in the present, where  $HF$  is suppos'd to be 8000, and the Angles  $ONP$ , as well as  $SQR$ , only differ, as  $HF$  has more or fewer Parts of  $DC$ . Thus,

TABLE I.

| Sine<br>$H F$ | Arch<br>$A F$ | Angle<br>$O N P$ | Angle<br>$S Q R$ |
|---------------|---------------|------------------|------------------|
| 1000          | 5° 45'        | 5° 42'           | 165° 41'         |
| 2000          | 11 32         | 11 20            | 151 28           |
| 3000          | 17 27         | 16 58            | 137 6            |
| 4000          | 23 35         | 22 30            | 122 40           |
| 5000          | 30 0          | 27 52            | 108 12           |
| 6000          | 36 52         | 32 56            | 93 44            |
| 7000          | 44 26         | 37 28            | 79 22            |
| 8000          | 53 8          | 40 44            | 65 46            |
| 9000          | 64 10         | 40 56            | 54 26            |
| 9500          | 71 49         | 37 34            | 51 50            |

TABLE



TABLE II.

| Sine<br>H F | Arch<br>A F | Angle<br>O N P | Angle<br>S O R |
|-------------|-------------|----------------|----------------|
| 7000        | 44° 26'     | 37° 28'        | 79° 22'        |
| 7100        | 45 51       | 37 50          | 78 0           |
| 7200        | 46 4        | 38 12          | 76 38          |
| 7300        | 46 54       | 38 36          | 75 12          |
| 7400        | 47 44       | 39 0           | 73 46          |
| 7500        | 48 36       | 39 20          | 72 24          |
| 7600        | 49 28       | 39 40          | 71 2           |
| 7700        | 50 22       | 39 56          | 69 44          |
| 7800        | 51 16       | 40 16          | 68 20          |
| 7900        | 52 12       | 40 32          | 67 0           |
| 8000        | 53 8        | 40 44          | 65 46          |
| 8100        | 54 6        | 41 00          | 64 24          |
| 8200        | 55 6        | 41 8           | 63 12          |
| 8300        | 56 6        | 41 20          | 61 54          |
| 8400        | 57 9        | 41 26          | 60 42          |
| 8500        | 58 13       | 41 30          | 59 32          |
| 8600        | 59 19       | 41 30          | 58 26          |
| 8700        | 60 28       | 41 30          | 57 18          |
| 8800        | 61 39       | 41 22          | 56 18          |
| 8900        | 62 52       | 41 14          | 55 16          |
| 9000        | 64 10       | 40 56          | 54 26          |
| 9100        | 65 31       | 40 34          | 53 38          |
| 9200        | 66 56       | 40 4           | 52 58          |
| 9300        | 68 27       | 39 26          | 52 24          |
| 9400        | 70 4        | 38 36          | 52 2           |
| 9500        | 71 49       | 37 34          | 51 50          |
| 9600        | 73 45       | 36 6           | 52 6           |
| 9700        | 75 56       | 34 12          | 52 46          |
| 9800        | 78 32       | 31 32          | 54 10          |
| 9900        | 81 54       | 27 10          | 57 26          |
| 9950        | 84 17       | 23 50          | 61 54          |

The Inferences  
made from  
these Tables,  
by the present  
Philosophy.

Thaumaf.

Thaumant.

Cap. 3. §. 9. 10.  
11, 12, 13, 14.  
Par. 2.

§. 25. From these two preceding Tables, it is observ'd, that there are abundance more Rays which make the Angle  $ONP$  about  $40$  or  $41$  Degrees, than there are which make a less, or which make the Angle  $SQR$   $51$  or  $52$  Degrees than there are which make a greater. It is likewise remarkable, that  $ONP$  is the greatest at  $41^{\circ}, 30'$ , before and after which it diminishes, and  $SQR$ , the least at  $51^{\circ}, 50'$ , before and after which it increases, add therefore to the former about  $17'$ , for half of the *Sun's* apparent Diameter, and  $41^{\circ}, 47'$ , will be the largest Semidiameter, or utmost height of the Interior Bow; Subtract the same from the latter, and it gives the least height or Semidiameter of the Exterieur Bow, namely,  $51^{\circ}, 33'$ . Lastly, all the Rays betwixt the Sines  $8000$  and  $9000$ , after two Refractions and one Reflection, come out of the Globe in an Angle  $ONP$  of about  $41$  Degrees, by which means the Rays which are refracted to the Eye in that Angle, are more numerous, and have a denser and closer Disposition, than in any other; On the contrary, all the Rays betwixt  $9200$  and  $9700$ , after two Refractions and as many Reflections, come out in an Angle  $SQR$ , of about  $52$  Degrees, upon which Account the Rays will be likewise refracted to the Eye, in greater plenty, under that Angle, than any other, but not in above half the Proportion of the former; the Difference betwixt  $8000$  and  $9000$  being  $1000$ , which is double of  $500$ , the Difference betwixt  $9200$  and  $9700$ .

These Tables  
differ amongst  
one another.

§. 26. We shall therefore suppose all these Calculations to be true, and the Tables form'd upon them, notwithstanding that they in some measure differ from *Mariot's*, and others, which have been made, by those who have enter'd into the same Subject, as well as *Cartes's*, the first Promoter, tho' not Inventor of this Doctrine, and which it self would be a Confutation of Such an Hypothesis, that, even in a  
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Mathematick Calculus, there is not an Exactness agreeable to a Geometrick Reasoning; let these Tables, however, be imagin'd to be true, we shall first consider what Natural Deductions may be made from them, and afterwards inquire what Consequences are drawn, in order to prove the present Hypothesis.

§. 27. The first thing we shall examine into, is, the Sines, which are made use of in the preceding Tables; in the First of which, there is the Difference of a thousand Parts betwixt the one and the other, and in the Second, of a hundred; in the former Case, the Radius is divided into 10 Parts, each of which comprehends 1000 ten thousandth Parts, and in the last, into a hundred, each of which contains 100 ten thousandth Parts, but such a Division as this, when apply'd to an almost infinitely small Globe of Water, whose Dimensions scarcely exceed the Limits of a Point, as in the Rain-bow, is altogether inconceivable and incredible, so as to be capable of producing the Tables before describ'd; for where the Points in the Circumference *K* and *D*, Fig. §. 3. approach extremely near to each other, it is impossible *KE* *M* should make an Angle of about 52 Degrees, whilst *DE* with *EM* constitute one of about 41 Degrees, only; all the Rays will rather be refracted to *ZM* under one Angle, and so make one Lucid Point, without any manner of Distinction.

§. 28. Besides, if we consider a Globe of Water, which has a visible Magnitude and Size, it is evident from these Tables, that from 54°, 6', to 62°, 53', the Angle *ONP*, is 41°, and Minutes not exceeding 30, so that all the Rays, which are incident betwixt 9 or 10 Degrees nearly, are refracted to the Eye under the same Angle, with a difference, that lies within the Limits of 30 Minutes; but how Rays, which are refracted to the Eye, with the Difference of 30 Minutes, should only and

*Considering the smallness of the Globe, these Distinctions of Angles in the Tables are inconceivable.*

*The Magnitude of the Globe not determin'd, and therefore the Calculation not agreeable to Nature, but an Abstracted Reasoning. Thaumaf. Thaumant. Cap. 4. §. 10. p. 145.*

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principally fall within the Circumference of the Pupil of it, which is suppos'd to be fix'd in a determin'd Situation, rather than any Difference of 40 or 50 Minutes, or 5 or 6 Degrees, will not be easily explain'd, since the Compass of 30 Minutes may not be larger in the Refractions of some certain Globes of Water, than 5 or 6 Degrees are in others; but these Tables are calculated without considering the Magnitude of the refracting Globe, which notwithstanding ought to be ascertain'd in a true and real Computation, and are therefore to be rejected in a just Account of Nature, as a bare and abstracted Reasoning of the Mind, without any particular Application.

30 Minutes the utmost Difference of the Rays seen by the Eye, or not, either of which involves an Absurdity.

§. 29. Farther, let 30 Minutes be the utmost Difference, in which any Rays can be seen by the Eye, or not; if not, where must we stop, or what Reason can be assign'd, why a greater Latitude of the refracted Rays may not fall under our Observation, and if so, why we may not see them to some few Degrees, as well as to several Minutes, at least to  $40^{\circ}, 4'$ , on the one hand, and to  $40^{\circ}, 44'$ , on the other; if 30 Minutes is the utmost difference, how, in the Angle  $SQR$ , we should comprehend by our Sight all the Rays, which are refracted from  $51^{\circ}, 50'$ , to  $52^{\circ}, 58'$ , on the one hand, or  $52^{\circ}, 46'$ , on the other, the Difference of which is  $1^{\circ}$ , and  $8'$  in the first Case, and  $1^{\circ}, 4'$  in the last, will be impossible to say; Lastly, if  $1^{\circ}, 8'$  is acknowledg'd to be the Difference under which the refracted Rays will be visible to us in  $SQR$ , then all the Rays in the Angle  $ONP$ , which are refracted to 40 Degrees 44 Minutes, and less, will be apparent to us, which will not agree with the heighth of the Rainbow, its Semi-diameter being observ'd, at the lowest, to be much higher, namely, above 41 Degrees, and not much less than 42, and sometimes 44 or 45.

Sir Is. Newt.  
Opticks, Prop.  
9. Book 1. Par.  
2.  
Thaumaf.  
Thaumant.  
Cap. 6. §. 8.  
P. 173.

§. 30. We must likewise observe, that it is af- *The Rays which*  
firm'd, the Rays which fall betwixt the Sines 9200 *fall betwixt the*  
and 9700, and which are refracted to the Eye in *Sines 9200 and*  
the Angle  $SQR$ , of about 52 Degrees, are but *9700 in these*  
half so many as are refracted in the Angle  $ONP$ , *Tables, consi-*  
of about  $41^\circ$ , betwixt the Sines 8000 and 9000; *der'd.*  
whereas in these Tables the Angle  $ONP$ , of  $41^\circ$ ,  
reaches from 8100 the Sine, to 8900, and the Angle  
 $SQR$  of  $52^\circ$ , from 9200 the Sine, to 9700, and there-  
fore have not the Difference of 2 to 1, which is  
asserted, and made one Reason why the Light of  
the exterior Rain-bow is more faint and languid  
than the interior, since, at the most, it will be only  
as 8 to 5. 2d, The Angle of Egress  $ONP$  of  $41^\circ$ ,  
reaches from the Angle of Incidence  $54^\circ 6'$ , in the  
Tables, to  $62^\circ 53'$ , that is, the Latitude which the  
Incident Rays, in such a Case, take up, is  $8^\circ 47'$ , on  
the other hand, the Angle of Egress  $SQR$ , of  $52^\circ$ ,  
extends from the Angle of Incidence  $66^\circ 56'$ , to  
 $75^\circ 56'$ , in the Tables, and consequently takes up  
 $9^\circ$ , which is a greater Latitude than the former.  
So that if we suppose a Ray to fall on every Point  
of the Curve of  $8^\circ 47'$ , and on that of  $9^\circ$ , (and why  
we may not as well imagine the Archs to be the  
Measure of the incident and refracted Light, to  
which they are immediately contiguous, as the  
Sines which are drawn within the Globe, and to  
which the Incident Light do's not arrive but by  
Refraction, will be difficult to determine,) if they  
may be esteem'd the Measure as justly as the other,  
there will be more Light refracted under the Angle  
 $SQR$  to the Eye, than in the Angle  $ONP$ , since  
 $9^\circ$ , the Measure of the Incident Light, in the for-  
mer Case, is greater than  $8^\circ 47'$ , the Measure of  
it, in the latter; which, if allow'd of, will perfectly  
destroy, and overturn the present Doctrine of the  
Rain-bow.

*An Objection  
against these  
Tables, that  
7400 to 7900,  
the Angles  
ONP do not  
differ from each  
other above  
1°, 32'.*

§. 31. That, moreover, which is an Invincible Objection against these Tables, is, that from 7400 to 7900, the Angles *ONP* do not differ from each other above 1° 32', which much less exceeds 1° 8', the difference of the Angles *SQR*, which lie betwixt 9200 and 9700, than 1°, 8', exceeds 30', the Difference between the Angles *ONP*, which lie from 8100 to 8900, but these two latter are suppos'd to be seen under one Angle, the one of about 52°, and the other 41°, and for the same Reason the former ought to be visible, under an Angle of about 39°, from whence it will follow, that in the Globe of Water there should be another Lucid Point, apparent under a third Angle, as well as under the other two of 41°, and 52°, namely, under that of 39°; Moreover it is evident, in the first Table, that 8000 the Sine and 9000, have Angles *ONP* of 40°, 44', and 40° 56', when in the second Table, all that Series of Angles of 41°, by a gradual Computation of the Angles, which answer to the Sines, which are increas'd only by 100 Parts, is produc'd; it is not certain therefore but in the second Table as many the same Angles may be produc'd of different Degrees from 41, as there are of 41, where the Series proceeds by 100 Parts, in some Difference or other of a 1000 in the first Table, that is, if the Series of Angles was to be calculated with the Difference of 30, 50, 70, parts, &c. but why the Difference of 100 should ascertain the Number of the same Angles, under which the Lucid Point is seen, rather than any other Difference of 30, 50, &c. is not manifest.

*The Lucid  
Point in the  
Globe, not ex-  
plain'd.*

§. 32. What likewise is altogether inconceivable in this Abstracted Reasoning, is, and which is the Foundation of the whole, that to make a Point Lucid in the Globe, there must be the Incidence of Rays, from either 8100 to 8900, or else from 9200 to 9700, viz. the full Latitude of 800, or at least



800 Parts; since the Incidence of Rays, within the Limits of 1, 2, 3 or 4 hundred Parts, ought to produce a Lucidness proportional to their several Numbers, as 8 or 5 hundred do's.

§. 33. We may also take notice, that the Eye is suppos'd in a fix'd Situation, and yet no Account is given why it should be in that Situation, and whether receive the Rays, which are refracted under an Angle of 41 or 52 Degrees, than those which are under one of 39 or 73, or any other Angle; for altho' it should be Matter of Fact and Experience, that the Colours, in the Globe, are only visible in the Angles of 41 or 52 Degrees, to suppose such a Refraction and Reflection, which these Tables prescribe, is the Cause of those Appearances, is to suppose the Question, unless it be first evidenc'd, that we cannot see refracted Light under any other Angles; for Instance, if the Eye is remov'd farther from *E*, Fig. §. 3. in which the Rays that were refracted under the foremention'd Angles were seen, towards *Z*, so as to make the Angle *ONP*, in the Tables, 39°, or *SQR* 73°; either the Refractions of Light are seen under these Angles, or not; if they are, there will be other Lucid Points, than those which this Doctrine asserts; if not, a Reason should be assign'd, why they are only visible in the Angles 41 and 52 Degrees, which can be no other than the Numerousness of the Rays, which are refracted under those Angles, and which, by the preceding Sections, cannot be admitted as a just one.

§. 34. We must farther add, that by Experiment it is said, if *BC* or *CD*, Fig. §. 3, are intercepted, the Lucid Point vanishes at *D*, and at *K*, if *GH*, *VI*, or *IK* are, and yet, by the Latitude which is given to the Incident Rays of 800 or 500 Parts in §. 32, if those Lines in particular were intercepted, there would be room enough for the Refraction of Rays sufficient to produce a Lucid Point

*Why the Eye should receive Rays under Angles of 41 or 52 Degrees especially, not accounted for.*

*The Vanishing of the Lucid Point by intercepting certain rays, not solv'd.*

in  $D$  or  $K$ , which is a Demonstration that these Experiments are wonderfully nice, where an Hypothesis is to be maintain'd, and the Reasonings as large, where all is to be resolv'd into Calculations.

*How a Tangent to the Globe should be refracted, or reflected, inconceivable.*

Cartes Meteor.  
Cap. 8. §. 10.  
Tab. 1.

§. 35. In the first of these Tables, it ought to be likewise remark'd, that where the Sine  $HF$  is 10000, and the Arch  $FG$ , 0, that is, where the whole Sine is exhausted towards  $D$ ,  $ONP$  is  $13^{\circ} 40'$ , and  $SQR$ ,  $69^{\circ} 30'$ , which seems to be strange and surprizing, that where a Ray falls as a Tangent to the extremity of the Diameter of the Globe, it should be refracted or reflected at all, as also, that  $ONP$  should be  $41^{\circ} 30'$ , where the Sines have a Difference of 100 or 200 Parts in the Second Tables, that is in the Sines of Incidence 8500, 8600, and 8700, the Angle  $ONP$  which corresponds to each, is a-like computed at  $41^{\circ} 30'$ ; from which last Instance, we may conclude that the Calculation is made very much in favour of the Angle of  $41^{\circ}$ , so necessary to this Doctrine that the Accuracy of these Tables is not much to be depended upon, and that at least Rays, which fall at 200 Parts distance from each other, may be consider'd as one, which, we may add, will not contribute much to the Numerousness of the refracted Rays, when so many have the same Effect, as one only would have.

*How a multitude of Rays should be refracted under one Angle, and in one Point, not so be apprehended.*

§. 36. Lastly, if a multitude of Rays were refracted under one and the same Angle of  $41$  or  $5$  Degrees, either those Rays are Distinct and Individual ones, or not; if they are not, there will be no difference betwixt 1 and 100 or 200, which are refracted under the same Angle; if they are, how 100 or 200 Rays, should be refracted under one Angle, and in one Point, will be impossible to conceive, according to the Notions of the present Philosophy, that is, how 100 Rays, which possess each its own Space, should be contracted into a Space which is a 100 times less, and yet preserve their Dimensions.

§. 37. Besides these, there are other Calculations invented by Mathematicians, which, as they depend upon the same Principles, do of course terminate in the same Conclusions, which therefore we shall not at present consider, but having examin'd into the Tables themselves, abstractedly from any thing else, we shall now inquire into the use, which is made of them.

§. 38. The First is, That *GD*, Fig. §. 3, in the Globe of Water, which refracts the Rays under an Angle of about 41 or 42 Degrees, ought to appear more Bright and Luminous, than other Parts of the same Globe, because 41°, 30', is the utmost Term, beyond which no Light is refracted to the Eye, and under that Angle of 41°, there is more Light refracted to the Eye, than under any, which is less; besides, it is said, that the Light which comes out from the Globe, under any less Angles, cannot give a Disturbance or Impediment to that which comes out under 41°, since it do's not reach so far, from whence it is thought to follow, that, in that Angle, the Light will be collected and transmitted to the Eye, with a certain kind of Brightness and Splendour, whereas the Light, which has its Egress in lesser Angles, finds no Term or Point to which it is collected, that Angle, which comes out in a greater, still interfering with it, and disturbing and destroying the Collection, from whence it is inferr'd, a Brightness cannot exist any where, excepting in the aforementioned Angle of 41 or 42 Degrees.

§. 39. What is alledg'd in the foregoing Section is so imperfect, and so confus'd a way of Reasoning, that if there was nothing else against this Doctrine, it would give an Impartial Inquirer into the Nature of Things, a just and invincible Suspicion, that every thing, at least, was not true and exact which it propos'd, however, it may be thought to come under the Denomination of Mathematick Certainty; for, besides what has been said in §. 31.

*Other Calculations invented, but not consider'd, since they depend on the same Principles.*

*The Phenomenon of the Luminous Point asserted, from these Calculations.*

*Thaumas. Thaumant. Cap. 4. § 10, 11. p. 145, 146.*

*The Luminous Point may be seen under an Angle of 44 or 45 Degrees, which ill agrees with 41, to which it is fix'd by the foregoing Calculus.*



Thaumaf.  
Thaumant.  
Cap. 4. §. 10.  
P. 145.

32, which is a Confutation of this Account: We shall add, that  $41^{\circ} 30'$  in the Angle  $ONP$ , is affirm'd to be the utmost Term, beyond which no Light is refracted to the Eye, and which by the Tables is true, that being the greatest Angle, which we find under  $ONP$ , when presently after we are told, that a Brightness may be produc'd in an Angle of  $41$  or  $42$  Degrees, because it is justify'd in Fact, since in the Rain-bow it is known and confess'd, which appears in height even to an Angle of  $44$  or  $45$  Degrees.

Because more  
Rays appear  
under  $41$  or  $52$   
Degrees, no  
proof that there  
none appear un-  
der any other  
Angle.

Thaumaf.  
Thaumant.  
Cap. 4. §. 10.  
P. 145.

§. 40. As for there being more Rays refracted under the Angle of  $41^{\circ}$ , that has been already consider'd in the abovemention'd §. 31, 32, which, if acknowledg'd, would be of no Service to this Philosophy; since altho'  $GD$ , Fig. §. 3. was more Luminous than the other Parts of the Globe, by a greater Plenty of Rays coming out from thence, it would not be consequent, that those other Parts were not less Luminous, from  $GD$  being more, but rather infers and supposes it; And yet however sure, in the beginning of the present Section quoted, we might be, that the other Parts were less Luminous, towards the latter end of it, we are plainly made to know that they are not Luminous at all; so that because there are more Rays appear to the Eye under  $41$  or  $52$  Degrees, and for that very Reason, it seems, there are none appear to it under any other, which is a way of concluding, that has nothing else to excuse it, but the Modesty it makes use of, in endeavouring to palliate its Defects afterwards, and its being sensible of them.

That Rays  
which are re-  
fracted in An-  
gles less than  
 $41$  Degrees, are  
not collected to  
a Point, not  
prov'd.

§. 41. For, perceiving this would not be sufficient, notwithstanding which, this is all which can be justly deriv'd or concluded from these Tables; it immediately subjoyns, that the Rays, which are refracted in Angles that are less than  $41$  Degrees, are not collected to a Point, because the Rays, which

which are refracted under a greater than them, disturb and disorder the Collection, whereas those of 41 Degrees have none above them, and therefore find no Impediment or Obstruction to their assemblage, since those that are refracted in a less Angle, than that of 41 Degrees, do not reach those, which are refracted under a greater: But certainly under whatever Angle the Rays are refracted, they do not interfere with one another, seeing it is own'd, that those which are refracted under a less Angle, cannot reach those which are refracted under a greater, for otherwise they would disturb the Collection of those Rays, which are refracted in an Angle of 41°; and for the same Reason, that Rays, which are refracted under a less Angle, cannot interfere or meet with those that are refracted under a greater, those, which are refracted under a greater, cannot meet or interfere with those which are refracted under a less, and therefore will not cause any disturbance in the Collection of them; the plain Fact is, that every Ray is distinct, according to its different Angle of Refraction, and consequently there is no Interfering with each other, nor any Interruption from thence to the Collection of Rays, under what Angle soever they are refracted.

§. 42. The Second Application of these Tables, *The Application of this Calculus to the Drops of Rain in the Air.* is to the little Drops of Water, which hang in the Air after Rain, and by two Refractions and one Reflection of which, the Rain-bow is suppos'd to be produc'd, namely, that from these Tables, and the Consequences which are drawn from the Explication of 'em in the preceding Sections, there ought to appear in the little Drops of Rain one Lucid Point only in an Angle of 41 or 42 Degrees, made by the refracted Ray, and the Line drawn to the Eye from the Centre of the *Sun*, and continu'd to *M*, Fig. §. 3. but as this is affirm'd to be a Consequence of the first Application, of

these Tables to the present Doctrine, which was, that the Rays refracted under  $41^{\circ}$  or  $42^{\circ}$ , are those only which are Lucid, it will not require any farther Confutation; however, since there is something more alledg'd, concerning the Lucid Points of Globes in the Air, than was consider'd before, we shall proceed to examine this Assertion also, upon the Allowance and Supposition of what has been already disprov'd.

*The Globe upon which this Calculus is made, if carry'd to the Distance of the Rain-bow, would disappear, and consequently the Lucid Point in it.*

§. 43. What first strikes us with Admiration is, that any one should be able to persuade himself, that, because there is a Lucid Point appears in a Globe at about an Angle of  $41$  Degrees, therefore by being farther remov'd from the Eye, by which means the Object is in proportion diminish'd, it is probable that the Lucid Point will be magnify'd into a Bigness and Breadth, much greater than the whole Globe, with which this Experiment is made; for supposing this very Globe of Water was elevated to the Height of the Rain-bow, and made to be pendulous in the Air at the Distance the Rain-bow keeps to us, can we imagine, when the Globe it self, by its remoteness, would disappear, that we should be able to discern any particular Radiant or Luminous Point in it? it seems to be altogether impossible, and may be easily contradicted by Experience, since if the Globe of Water is remov'd to a considerable Distance, altho' it preserves the Angle to the Eye, there would be no Colours, nor no Radiancy visible from it.

*The Drops of Rain less than the Experimental Globe.*

§. 44. If this Globe, which is of a Definite Magnitude, will not serve the turn of a Double Refraction, and one Reflection, a smaller will be much less capable of doing it; and that Rain falls in a larger, or that the Dew which succeeds it do's, has not yet enter'd into any Philosopher's Head, however irregular and extraordinary, to assert.



§. 45. And yet supposing the Drops of Rain never so large, unless they were of as wide a Circumference as the Sky it self, this Experiment of a Globe of Water, would signify nothing to the purpose; for the Angle of 41 Degrees, in the Rain-bow, is measur'd by the Degrees in the Heavens, and the 17 Minutes the apparent Diameter of the Sun, which is added to the height of the Rain-bow, is computed by the same Degrees, by which means the Lucid part of the Heavens is determin'd, and the Rays, which constitute it, must be suppos'd to come out in an Angle of such Degrees, or else to come out in very different Angles, which would, according to the Tables, and the Inferences drawn from them, produce no Lucid Point at all.

*To make this Calculus square with a Drop of Water in the Heavens, the Ambitus of it should be as great as that of the Sky it self.*

§. 46. Lastly, if this could be allow'd, that a Drop of Rain was as large as the whole Circumference of the Heavens, the Tables propos'd to us would be of little Significance, since the Lucid part of that Circumference is not fix'd to 41 or 42 Degrees, but is sometimes found to the Elevation of 44 or 45, of which no other Account is given than the different Heat or Coldness of the Water, which refracts the Rays; but how so weak and languid a Force, for we may call 'em so in this respect, as that of Heat or Cold should cause a Refraction of Rays of 3 or 4 Degrees difference in the Heavens, is inconceivable, or which way such Refractions should be seen by the Eye, so as to make one Lucid Appearance is altogether as impossible.

*The Lucid Point changing its Elevation, not accounted for from Heat and Cold. Thaumaf. Thaumant. p. 172, 173.*

§. 47. What has been demonstrated against this Doctrine, in relation to the Primary Iris, which is said to appear under an Angle of about 41 or 42°, is equally valid against the Secondary, which is likewise affirm'd to appear under an Angle of about 52°, we shall not therefore have occasion to consult any farther Accounts of the Breadth of the

*What is demonstrated against the First Iris, is, some allowances being made, equally valid against the Second.*

Rain-

Thaumant.  
Thaumant.  
Cap. 4. §. 12.  
P. 147.

Rain-bow, or the utmost or least Diameter of either, which all depend upon this kind of Reasoning, and which we hope has been abundantly confuted; that which remains, is to consider how the Lucid Point, which has not been prov'd, is divided into several Colours, an Explication of which will require other kind of Principles than what are laid down, either in this or in any other System.

The Colours of  
the Bow inex-  
plicable, from a  
Termination of  
Shadow.

Cartes. Princ.  
Rohault Cap.  
27. §. 65. &c.  
Part. I. Cap. 17.  
§. 8. P. 3.

§. 48. Let us grant therefore still as much as is possible, that the Lucid Part of the Dew is made by this Reflection and these Refractions, and that it is apparent under an Angle of 41 or 42 Degrees only, yet that this Lucid Part should be distinguish'd into a particular Variety of Colours, there is no just Reason assign'd. The first is, that since there are no Rays refracted to the Eye beyond 41 or 42 Degrees, what terminates upon those Rays is Shadow, which, according to this Theory, has a certain Influence in changing the Temper and Complexion of the refracted Rays, and impressing upon them a different, which is as much as to say, an Absence of Rays is capable of producing an Effect, by their Action, upon Rays, to which they were never present, which is impossible, but this Philosophy has been already consider'd, and refuted Chap. II. §. 28.

If this Account  
do's not explain  
the Colours of  
the Iris, the  
whole Doctrine  
must be false, so  
far as it relates  
to that Pheno-  
menon.

§. 49. The former Account of Colours, it will therefore be said, is justly exploded, and if so, it is certain, that altho' every thing else was true, it would give a very deserv'd Impression upon a rational Mind, that all which is propos'd upon this Hypothesis is false; for if Shadows cannot have any Influence in the forming of Colours, that is, if, by this Philosophy, the Colours of the Rain-bow are not explain'd, which is the principal Phenomenon in it, all the rest, about the Angle and Lucid Point, will be idle and insignificant, and the one calculated, and the other inferr'd, to no man-  
ner

ner of Purpose, for what a poor Appearance would a Rain-bow make, without so much as one Colour painted upon it? Or how would this be to account for Nature, when no such thing was ever observ'd in it?

§. 50. However, there is another Solution given of the Partition of Colours, besides that of Shadow environing these Refractions, which is the Constipation or Condensation of the Rays that are refracted under the Angle of  $41^{\circ}$ , from whence the Globuli of the Rays are revolv'd into a Vertiginous Motion, which Opinion we have examin'd before, Chap. II. §. 28. and shall only add, If a Condensation of the Rays could produce any thing, we might expect, not an Alteration of the Rays to different Colours, but a more Intense Light from them, since that, in this very Philosophy, is said to be the Effect of several Rays coming out under the same Angle, in so many Sections, as are brought to prove there is a Lucid Point in the Globe apparent, under an Angle of  $41$  and  $52$  Degrees, what therefore remains, is, that Account, which is given us from the late Theory of Colours, and which we shall in the next Section consider.

*The Explanation of the Colours from a Constipation of the Rays, absurd.*

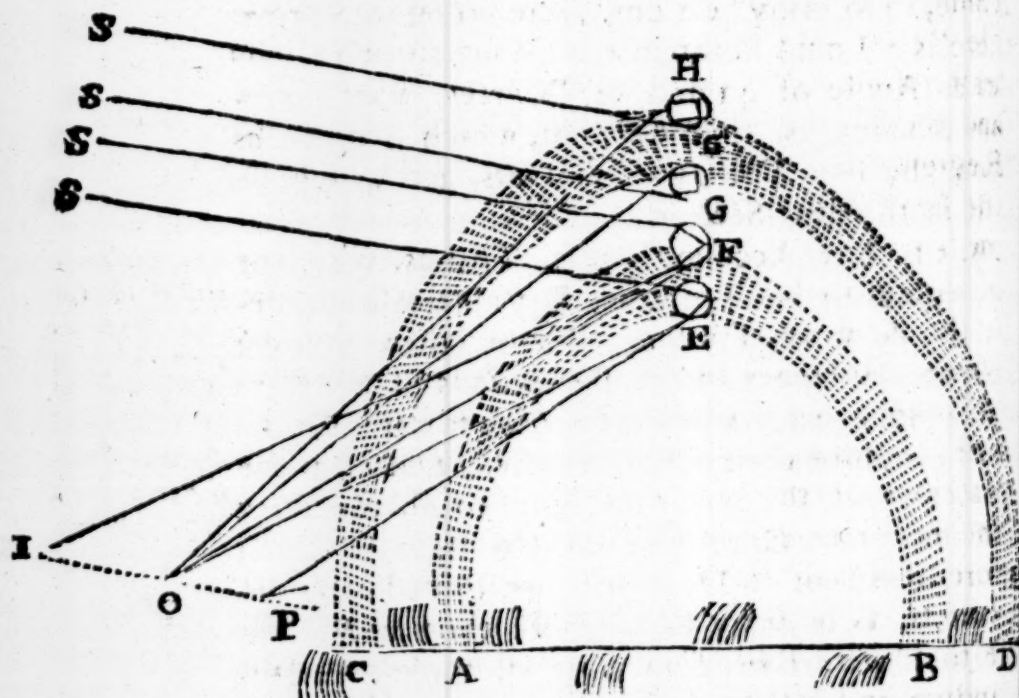
Thaumas.  
Thaumant.  
Cap. 4. §. 4.  
p. 139, 140.

§. 51. The Account is this, That as, when the Sun comes to his Tropicks, Days increase and decrease insensibly, for some time together, so there is little Difference in the Refractions of the Rays *EF*, (Fig. §. 24.) when they arrive towards the utmost Limits of their being refracted, that is, as the Distance of *CL* approaches nearer to *D*, the Rays *EF* fall upon a Curvity of the Quadrant, in which the Distinction of Degrees is not so plain and determin'd, as in other Parts of it; thus in *FD* the Rays which are incident upon it, come closer together than in *FA*, and are therefore refracted in greater plenty from *N*. It is farther alledg'd, that those Rays, which differ in Refrangibility, will have different Limits of their Angles of Emergence,

*The Explanation of the Colours from the New Theory of them, propos'd.*  
Sir Is. Newt.  
Opticks Prop.  
9. Par. 2. Book  
1. p. 128.



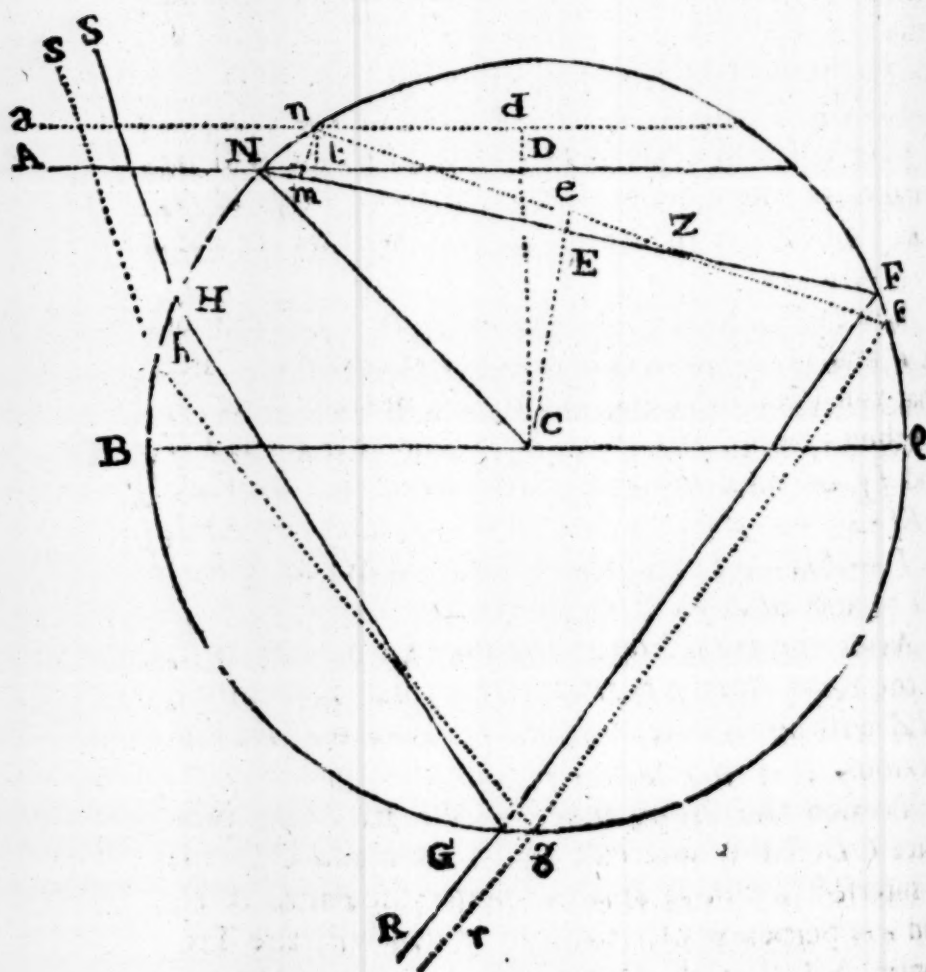
mergence, so that  $NTU$ , or  $ERT$  will be vary'd according to the greater or less Degree of Refrangibility in the Rays, and yet all of 'em will be more copiously refracted from  $N$ , than from any other Part, and by their differing Forces will be separated from each other, and carry'd to distinct Intervals in  $PT$ ; these Angles are found by a Mathematick Computation, which depends upon a double Refraction, and one Reflection, as before, thro' a Globe of Water, and differ only in their Accuracy, and upon the Account of the Various Refrangibility of the Rays; for in the least Refrangible Rays, the Sines of Incidence and Refraction  $CL$  and  $CI$ , are as 108 to 81, from whence  $ETT = NTU$ , or the greatest Angle of Emergence will be  $42^{\circ}.2'$ , and in the most refrangible Rays, the Sines  $CL$ ,  $CI$ , are as 109 to 81, and from thence  $NPV$  will be found to be  $40^{\circ}.17'$ , on the



other hand,  $GRN$ , or  $ERZ$ , or the least Angle of Emergence, in the least refrangible rays, will be  $50^{\circ}.57'$ , and in the most,  $54^{\circ}.7'$ . After this, it is suppos'd Fig. §. 51. that  $O$  is the Eye of the Spectator, that

$OP$  is a Line drawn parallel to the Incident Rays, and  $POE, POF, POG, POH$  are respectively Angles of  $40^{\circ}. 17', 42^{\circ}. 2', 50^{\circ}. 57', 54^{\circ}. 7'$ , and that  $OE$  and  $OF$ , or  $OG$  and  $OH$ , turn'd round upon the Centre  $O$ , describe severally the Circumferences of the Base of two different Cones, which Circumferences are the Limits of the Rain-bows  $AFEB$ , and  $CHGD$ ; It is moreover said, that as to the Drops of Water  $E, F, G, H$ , where-ever they are plac'd in the Peripherys describ'd by  $OE, OF, OG, OH$ , if they are illuminated by the *Sun's* Rays  $SE, SF, SG, SH$ , the Angle  $SEO$  will be equal to the Angle  $POE$ , or  $40^{\circ}. 17'$ , the greatest, in which the most refrangible Rays can, after one Reflection, be refracted to the Eye, and therefore all the Drops in  $AEB$  will have the same Property, by which means the deepest Violet Colour will be only visible in that Region; in like manner the Angle  $SFO$  will be equal to the Angle  $POF$ , or  $42^{\circ}. 2'$ , the greatest, in which the least refrangible Rays are refracted to the Eye, and therefore the deepest Red will be seen in that Region, or in the Circumference  $AFB$ ; and, by the same Argument, the Globes which are intermediate to  $F$  and  $E$ , will refract to the Eye Rays of intermediate Degrees of Refrangibleness: Nor is the Reasoning different in the Secondary Iris, where  $SGO$  is equal to the Angle  $GOP$ , or  $50^{\circ}. 57'$ , and  $SHO = POH$ , or  $54^{\circ}. 7'$ , the first (contrary to the other) expresses the Refractions of the least refrangible, and the last, of the most refrangible Rays, to the Eye, and therefore represent the Colours in an inverted Order, that is, as before the Series of the Colours from  $F$  to  $E$  were Red, Orange, Yellow, Green, Blue, Indico, and Violet, so here from  $G$  to  $H$  they obtain that Order; The Breadth also of the Interior Bow  $EOF$  is  $1^{\circ}. 45'$ , that of the Exterior  $GOH$ ,  $3^{\circ}. 10'$ , the Distance between the two Bows  $GOF$

$8^{\circ}.55'$ , the greatest Semidiameter of the Innermost, viz.  $POF$ ,  $42^{\circ}.2'$ , the least Semidiameter of the outermost,  $POG$ ,  $50^{\circ}.57'$ . This would be, if the Sun were but a Point, for by the Breadth of his Body, the Breadth of the Bows will be increas'd, and their Distance diminish'd by  $30'$ , and consequently the Breadth of the Interior Iris will be  $2^{\circ}.15'$ , of the outer  $3^{\circ}.40'$ , their Distance  $8^{\circ}.25'$ , the greatest Semidiameter of the Interior,  $42^{\circ}.17'$ , and the least of the outermost  $50^{\circ}.42'$ , which are the Dimensions of the Bows observ'd in the Heavens



very nearly. We shall subjoyn a Calculus of the Angles of the Iris, communicated to me by a very Learned and Ingenious Friend.

Suppo-



Supposing the same Construction to be made, as in the Ninth Proposition of the First Book of Sir Isaac Newton's Opticks: the Rules, which he there delivers for computing the Angles of the Rain-bow, may be thus made out.

Let the Ray  $GR$  emerge after one Reflection at  $F$ . 'Tis to be observ'd, that the Parallel Rays, which are nearest to  $AN$ , do then emerge parallel to  $GR$ , when they meet at the Point of Reflection  $F$ . For let the Ray  $an$  be parallel, and the nearest to  $AN$ , and let it be refracted in  $nf$ , intersecting  $NF$  in  $Z$ , and be reflected in  $fg$ , and refracted again in  $gr$ . Then, if the Points  $Z$ ,  $F$  and  $f$  be suppos'd to coincide; since the Angles  $NFn$  and  $GFg$  are equal, and the Refractions at  $Nn$  and  $Gg$  are alike, the emergent Rays  $GR$ ,  $gr$  will be parallel in like manner, as the Incident Rays  $AN$ ,  $an$ . Therefore in this Case,  $NZ$  will be to  $EZ$ , as 2 to 1.

Let the Ray  $HS$  emerge after two Reflexions at  $F$  and  $G$ . 'Tis evident, as in the former Case, that the Parallel Rays, which are nearest to  $AN$ , do then emerge parallel to  $HS$ , when the Rays  $FG$  and  $fg$  become Parallel. Therefore in this Case  $2 Ff = (Ff + Gg = \text{Arch } FG - \text{Arch } fg = \text{Arch } NF - \text{Arch } nf =) Nn - Ff$ . Whence  $Nn = 3 Ff$ , and  $NZ$  to  $EZ$ , as 3 to 1.

After the same Method it may be prov'd, that, if the Rays emerge parallel, after three Reflexions,  $NZ$  will be to  $EZ$ , as 4 to 1: If, after four Reflexions, as 5 to 1, &c.

To find the Proportion of  $NE$  to  $ND$ ; produce  $CD$ , till it intersect  $an$  in  $d$ , as also  $CE$ , till it intersect  $nf$  in  $e$ , draw  $nt$  perpendicular to  $ND$ , and  $nm$  perpendicular to  $NE$ . Then will the Triangles  $NDC$ , and  $ntN$ ,  $NEC$  and  $nmN$ , and the whole Figures  $NDEC$ ,  $ntmN$  be Similar, and moreover,  $R : I :: (CE : CD :: Ce : Cd ::) Ee : Dd$ . And therefore  $NE : ND$

::

$$:: (nm : nt, \text{ or } Dd :: nm : Ee \quad NZ : EZ \\ Ee : Dd :: R : I ::)$$

$\frac{NZ}{EZ} R : I$ . Hence, if there be but one Reflexion,

$NE : ND :: 2 R : I$ . If two Reflexions,  $NE : ND :: 3 R : I$ . if three,  $NE : ND :: 4 R : I$ , &c.

To find the Proportion of  $ND$  to  $NC$  universally; put  $n = \frac{NZ}{EZ}$ , and you will have  $n R : I ::$

$NE : ND$ . Then (because  $CD^2 + ND^2 = NE^2 + CE^2$ , or  $CD^2 - CE^2 = NE^2 - ND^2$ ) it will be as  $CD + CE$  to  $NE + ND$ , so  $NE - ND$ , to  $CD - CE$ , or  $\frac{I + R}{I} CD : \frac{nR + I}{I} ND$

$$:: \frac{nR - I}{I} ND :: \frac{I - R}{I} CD; \text{ whence } ND^2 :$$

$$CD^2 :: II - RR : nnRR - II, \text{ and consequently}$$

$$ND^2 : NC^2 :: II - RR :: nn - I \times RR,$$

or  $ND$ , to  $NC$  as  $\sqrt{II - RR}$ , to  $\sqrt{nn - I \times RR}$ .

Therefore, if there be but one Reflexion,  $ND$  will be to  $NC$ , as  $\sqrt{II - RR}$  to  $\sqrt{3RR}$ ; if two Reflexions, as  $\sqrt{II - RR}$ , to  $\sqrt{8RR}$ ; if three Reflexions, as  $\sqrt{II - RR}$ , to  $\sqrt{15RR}$ , &c.

*The Comparison made from the Tropicks, consider'd.*

§. 52. In Answer to this Last, and Utmost Improvement of this Hypothesis of the Rainbow, we say, that in Fig. §. 24<sup>th</sup>, to conclude that more Rays are refracted in  $N$ , because they fall closer together in the Points betwixt  $F$  and  $D$ , than in those betwixt  $F$  and  $A$ , which is the meaning of the Comparison before alledg'd from the Tropicks, is to beg the Question; for altho' the *Sun*, to appearance, should move more slowly betwixt  $F$  and  $D$ , because it describes the same Degrees betwixt them with an equable Motion, as it did before betwixt  $A$  and  $F$ , and therefore in relation to  $DC$  will mark out more Points in  $DL$ , than in  $LC$ , in

Proportion

Proportion, yet the same is not certain in the incident Rays of the *Sun*, which are suppos'd to fall uniformly from one Point, and in equidistant and parallel Directions; either therefore there are more Rays suppos'd to fall parallel betwixt *F* and *D*, or *D* and *L*, in Proportion, than betwixt *F* and *A*, or *L* and *C*, and consequently more refracted at *N*, which is the thing in question, and is contrary to the other Supposition, which this Philosophy maintains, of Parallel and Equidistant Rays, and whose Number is to be computed by the Points in *DL*, *LC*; or if there are not, they cannot be compar'd to the insensible Increase and Decrease of Days at the Tropicks; however, if this Analogy was just, which we have at present only Reason to consider, from what has been already offer'd, concerning the Refractions at *N*, there cannot, as we have prov'd, be any thing rationally advanc'd from them, towards the Explanation of the Rain-bow, or even so much as of a Particular Lucid Point in a Globe of Water; and as to the Comprehensive Calculation before set down, since it depends, in the last Result, upon the same Principles with the *Cartesian*, of Reflections and Refractions thro' a Globe of Water, there is no occasion particularly to examine into it.

§. 53. It is in the next place affirm'd, That the Rays, which constitute the Lucid Point in *N*, (Fig. §. 24.) are variously refracted, according to their different Degrees of Refrangibility, and, by Computation, the least refrangible Rays, in their largest Angles *NTU*, will make  $42^{\circ}, 2'$ , and the most refrangible, in their largest Angle *NQU*,  $40^{\circ}, 17'$ ; the Grounds and Foundation of this Computus, we have, I say, already examin'd, and the Application here is only necessary to be inquir'd, which is to the Angles *FOP*, *EOP*, Fig. §. 51, the Analogy betwixt which, is no ways explain'd.

*The Rays which constitute the Lucid Point, variously refracted, according to their different Degrees of Refrangibility.*



The Angle  $\angle NTU$ , in both the Most and Least Refrangible Rays, calculated from the same Point  $N$ , do's not agree with the abstracted Calculation.

§. 54. Since, first, the Angle  $\angle NTU$ , (Fig. §. 24,) in both the Most and Least Refrangible Rays is calculated from nearly one and the same Point  $N$ , where, as in its Application to  $FOP$ ,  $EOP$ , (Fig. §. 51,) the Points  $E$  and  $F$  are  $1^{\circ}, 45'$ , distant from each other in the abstracted Calculation, supposing the Sun to be a Point, and in reallity with the Addition of the Sun's Diameter of  $30'$ , they are distant from each other  $2^{\circ}, 15'$  in the Heavens, unless therefore  $EF$  may be consider'd as a Point, that is,  $1^{\circ}, 45'$ , or  $2^{\circ}, 15'$ , what is alledg'd, in Fig. 24, concerning the Point  $NS$ , and the Refractions from it, cannot, in the least, be apply'd to  $EF$ , Fig. §. 51; but that  $EF$  is not consider'd as a Point, is evident, since  $30'$ , the Sun's apparent Diameter, when impress'd upon the Rain-bow, is not thought to be so, but makes an Addition of  $30'$ , to it, and therefore the remaining  $1^{\circ}, 45'$ , is much farther remov'd from one; if it be here said, that  $E$  and  $F$  may be suppos'd to coalesce, and all the difference thrown upon the Line  $OP$ , it will be, as was said before, altogether inconceivable, how Rays, which are refracted to  $OP$ , at the Distance of  $1^{\circ}, 45'$  in the Heavens, should be collected in the Eye at  $O$ , seeing the Pupil of the Eye can no more comprehend  $1^{\circ}, 45'$ , when before it could only in Fig. §. 24, the Point  $N$  nearly, than it can receive the Influx of Rays, which pass at some Distance above and below it; Lastly, as was before observ'd, the Globes  $E$  and  $F$  are suppos'd, in this Doctrine, to be of much larger Dimensions, than what we can possibly imagine to belong to the small Drops of Dew (if the Calculation of the Globe, in Fig. §. 24, is analogous to that in Fig. §. 51.) and therefore the whole incomprehensible.

All the Different Refrangible Rays are mixt in  $N$ , and therefore the

§. 55. There is another thing necessary to be consider'd in this Analogy, which is, that even in  $\angle NTU$ , Fig. §. 24, tho' the most and the least refrangible Rays should have the Angles, which are affirm'd

affirm'd by Computation, yet since all the different Point ought to be colourless. refrangible Rays are mixt in  $N$  and come to the Eye in the same Angle nearly, it would be consequent, according to this Philosophy, that there would be no Colours in  $N$ , but only a Lucid or White Point, contrary to the Experiment; or else, if the Rays were differently refrangible in  $N$  and not mixt together, there would be different Angles, under which different Colours would be refracted, but no certain one, as that of 41 or 52 Degrees, in which they came out in greater plenty, contrary to the Hypothesis of a Lucid Point, and the Calculations made to prove it, according to the foregoing Tables.

§. 56. We must likewise add, that if the present The Rays, if they came distinctly refracted to the Eye, would be subject to another, which is, that  $NTU$ , being the greatest Angle of the least refrangible Rays, and  $NQU$  of the most, it will follow, that *confus'd, and mix'd into a White.* there will be no Red Rays refracted any nearer to  $U$  than  $T$ , nor no Violet nearer than  $Q$ ; but it do's not from thence appear, that the Red may not be diffus'd from  $T$  to  $Q$ , and the Violet from  $Q$  to a farther Distance from  $U$ , and so the Rays of Intermediate Degrees of Refrangibility proportionably may be spread and enlarg'd towards  $Q$ , and indeed must be, unless there is only one Red Ray refracted at  $T$ , one Orange only in the next Degree of Refrangibility, and at last one Violet only at  $Q$ , which will not be sufficient to fill the Space  $QT$ , or the Eye, which is suppos'd to possess it. But if  $NT$  sends out several Rays towards  $Q$ , and the Orange, Yellow, Green, Blue, and Indico successively, do so likewise; suppose they reach as far as  $Q$ , there will be a Mixture of all the Rays, and a Violet will not there be produc'd, but a White; in the Indico all the Rays will be mix'd, except the Violet; in the Blue, all the Rays but Violet and Indico, &c. from whence will result a quite different Appearance

ance of Colours, from what is asserted; if they do not reach so far as  $Q$ , but each sort of Rays has its proper Limits, beyond which they do not extend, but are succeeded by others, then indeed the Colours in the Globe, as to their Orders, may be explain'd; but how this will agree with the Calculations made in the Tables, which fix the Lucid Point to one Angle  $NTV$ , of about  $41^\circ$ , or how they should appear in so short a Compass as the Pupil of the Eye, so that it should comprehend the whole Space  $QT$ , if the Rays were thus differently refracted to such a Distance from each other, as is suppos'd, will not easily be evinc'd.

*The Rain-bow would be seen in other places, as well as in one fix'd Lucid Point, if this Doctrine was true.*

§. 57. However, the Application of what is observ'd in a Globe of Water to the Rain-bow, is altogether inexplicable, not only upon the Accounts we have mention'd, but in respect of the Colours; for either  $E$  and  $F$ , Fig. §. 51, are presum'd to refract, the first none but Violet Rays, and the last none but Red, or not; if they are, they do not obtain the same Conditions with the Globe of Water, in Fig. §. 24, which is made to refract all sorts of Rays from the same Point  $N$ ; if they are not presum'd to refract one kind of Rays, but all the differently refrangible ones, and in Distinct Limits, peculiar to each sort of Rays, we must observe, that in so small a Drop, as  $E$  is imagin'd to be, in respect of the Globe of Water, in Fig. 24<sup>th</sup>, and suspended at so great a Distance as the Rain-bow, in respect of the Distance of that Globe, since  $TQ$  is acknowledg'd to come within the Verge of the Eye of the Observer, by which means he receives all the variously refrangible Rays from  $N$ , there is much more Reason to conclude that  $IO$  or  $OP$ , in Fig. §. 51 will, and therefore both in  $E$  and  $F$ , as before in  $N$ , all the several Colours of the Rain-bow will be seen, betwixt  $EO$ , the most refrangible Ray, and  $EP$  the least, and betwixt  $FO$  the least refrangible Ray, and  $FP$  the



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the most, which would be a full Confutation of this Hypothesis.

§. 58. Besides, supposing none but the most refrangible Rays of  $E$ , and the least of  $F$ , were visible to the Eye in  $O$ , for the same Reason if the Eye was remov'd to  $P$  or  $I$ , in the first Case, the Red would appear in  $E$ , and no Colour in  $F$ , because  $FO$  is the Term of the least refracted Rays, and in the last Case, the Violet would be seen in  $F$ , and no Colour in  $E$ , because  $EO$  is the Term of the most refracted Rays, and suitably there would be different Colours seen betwixt  $O$  and  $I$ , and  $O$  and  $P$ , from what are any ways existing in Nature by the Observations that have been hitherto made upon it.

*Another Objection against the Order of Colours, which results from this Doctrine.*

§. 59. That which makes this Philosophy the more obnoxious, is, that to reconcile this Reasoning, in Fig. §. 51<sup>th</sup>,  $SEO$  and  $SFO$ , are affirm'd to be equal to  $EOP$  and  $FOP$ , so that albeit in Fig. §. 24<sup>th</sup>, the particular Reflections and Refractions of the Globe are punctually asserted and describ'd, and  $FK$  is conceiv'd to be very different from  $FT$ , and the Angle  $FKN$  from the Angle  $ETN$ , in Fig. §. 51, they are suppos'd to be the same, when the Colours are to be explain'd, and the whole Matter is transacted without the least Refraction, and by one Reflection only, whereas the Computation of the very Breadth and Heighth of the Rain-bow depends upon two Sensible and Express Refractions, but to make use of Refractions to serve the Explication of some Phenomenons of the Rain-bow, and to reject them in others, is, at the best, to give a very Arbitrary Solution of the Whole.

*The Arbitrariness of this Doctrine, in sometimes making use of Refractions, and at others in rejecting them.*

§. 60. Lastly, if all this could be granted, the Heighth of the Interior Iris has been observ'd, to be near 45 Minutes, as was said before, whereas this Calculation determines it to about 42, and in some Extraordinary Appearances, they have been seen

*The Heighth of the Rain-bow, by Observation, not agreeable to the present Calculus.*

at almost all Angles of Projection, and even inverted, the Solutions of which, we shall not now examine, since the Ordinary Phenomenons of them are so little explain'd; as to the Exterior Iris, the Arguments for and against the present Accounts, which are given of it, depend upon the same Principles, and do not require a Particular Confutation.

*The Reason of  
our Dissenting  
from the pre-  
sent Philoso-  
phers.*

§. 61. To conclude this Part of our Principles of Natural Philosophy, we cannot but with some regret own, That we have been oblig'd by a steady Pursuit of what appear'd Rational and Just, in a real Search after Truth, to dissent from one of the Greatest and most Learned Men that the World has produc'd, Sir *Isaak Newton*, and who wants nothing to make the Exalted and Incomparable Genius he possesses more Celebrated, than any we meet with in History, of the Ancient Sages, either of *Greece* or *Rome*, than the Authority their several Empires gave to their Writings; and altho' the Arguments alledg'd against his Philosophy, we are certain are true, till we are convinc'd of the contrary, we cannot yet but acknowledge a Sagacity in every thing he proposes to us, almost Superior to what is call'd Human; on the other hand, excepting this Great Man, the Incomparable Dr. *Halley*, Dr. *Wallis*, *Borelli*, Mr. *Raphson*, Mr. *Boyle*, Mr. *Keil*, &c. excepting these, who seem to have been misled, where they have asserted the Corpuscular Philosophy, by Opinions only which have been taken for granted before them, may we not reasonably be astonish'd at those Men, who have had little other Learning, or Philosophy, than what the Corpuscular has supply'd 'em with, as *Hobs*, *Spinoza*, and *Locke*, and who in Confidence of this, have thought Themselves able to shake the Foundations of Religion it self: For if the Corpuscular Doctrine is False, let the Patrons and Favourers of those Elaborate Gentlemen look back, and inquire how many Pages of their Writings

ings will stand the Test of a True and Solid Reason-  
ing; if it be said, because the Corpuscular Philo-  
sophy, and a Passive Matter, has universally pre-  
vail'd, therefore by destroying that, we overthrow  
Religion; we in the first place reply, That the  
greatest Proof, which Philosophers have made use  
of for the Being of a GOD, from Material Sub-  
stances, is from the Motions observable in them;  
if therefore we evidence, that all Nature is active,  
and, that Matter it self is so, we are ready to think,  
and are fully perswaded, that such a System is more  
agreeable to the Divine Mind, than any other that  
can be suppos'd; not to mention in the second  
place, that those who have defended the Corpus-  
cular Philosophy, have, in Fact, been generally  
Atheists, as *Epicurus*, *Democritus*, and the rest of  
their Followers, and it may be very much que-  
stion'd, Whether the present Irreligion of the  
Times, is not owing, in a great measure, to the  
same Trifling and Absurd Pretences,

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F I N I S.

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